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July 31, 1990

Energy Research Abstracts

Abstracts 32036–33863

Office of Scientific and Technical Information
UNITED STATES DEPARTMENT OF ENERGY

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Energy Research Abstracts

Purpose

Energy Research Abstracts (ERA) provides abstracting and indexing coverage of all scientific and technical reports, journal articles, conference papers and proceedings, books, patents, theses, and monographs originated by the U.S. Department of Energy, its laboratories, energy centers and contractors. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations. Foreign information is obtained through the International Energy Agency's 14-nation Energy Technology Data Exchange, the International Atomic Energy Agency's International Nuclear Information System, or nation-to-nation agreements. **Please note that *ERA* coverage of nonreport literature is limited to that generated by Department of Energy activity.**

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The citations presented in *ERA* are available for online searching as records within the Energy Data Base. The current-year records are available on the Integrated Technical Information System (ITIS). The entire database is available through commercial online vendors.

Availability

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ERA is available to the public on a subscription basis from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The subscription rate for 24 semimonthly issues is $184.00 for domestic subscribers and $230.00 for foreign subscribers. A single issue costs $27.00, domestic, or $33.75, foreign. Cumulative indexes are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The GPO Stock Number is 061-000-00749-1 for the Volume 14 indexes.

Managing Editor, Audrey B. Smith
Technical Editor, Robert W. Rutkowski

Information Sources

The citations presented in *Energy Research Abstracts* are a subset of the worldwide energy information provided to the Office of Scientific and Technical Information (OSTI) through exchange agreements with foreign sources and through exchanges or contracts with U.S. organizations.

The **Energy Technology Data Exchange (ETDE)** was established by the International Energy Agency to promote cooperation among members in conducting appropriate energy-related research and development programs through the development of a formal central information sharing system. In accomplishing the objectives of the ETDE, members select, abstract, and index relevant research information published in their countries in accordance with Exchange standards. OSTI serves as the central receiving and processing center for this information, which it then disseminates to national centers in the participating countries. The following countries are currently members of the ETDE:

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The **International Nuclear Information System (INIS)** was established to promote the exchange of information on nuclear science and technology. Its operation is similar to that of the ETDE, with the INIS Secretariat being located in Vienna, Austria. Currently, 75 countries and 14 international organizations are members of INIS. OSTI serves as the INIS national center for the United States.

In the exercise of its rights and responsibilities under the agreements to which it is a party, the **Office of Scientific and Technical Information** both receives information from the above sources and submits U.S.-produced information to them. In addition to materials generated by the Department of Energy, this U.S.-produced information is gathered from other government agencies as well as under contract with private information processing companies. All input is computer processed and entered into a database for online retrieval. The database serves as well for the production of numerous OSTI publications.

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The coverage of literature in this publication includes several document types, ranging from technical reports to journal articles to books. The principal data elements included in these citations are:

1. **Abstract number** within volume.
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3. **Title and subtitle** (non-English title may appear in parentheses, if applicable).
4. **Author(s).** First 10 names in the data record are printed, then "et al." is listed.
5. **Author affiliation.** Only first one is listed, in parentheses after author(s) to which it applies.
6. **Collaboration,** if present.
7. **Corporate author(s)** identifying corporation responsible for document.
8. **Patent assignee and number** for citations of patent documents or applications.
9. **Journal title, volume, and issue** for citations of journal articles.
10. **Date of publication.** If not known, a processing date is in brackets.
11. **Number of pages** or page range.
12. **Language** of document if non-English.
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14. **Publisher's name and location** for documents published by a corporate or commercial source.
15. **Sponsoring organization.**
16. **Contract or grant number.**
17. **Secondary identifying number;** may be a conference number.
18. **Conference title, location, and date,** if applicable.
19. **Order number.** The "DE" order number may be used for ordering from NTIS or OSTI, as appropriate. The "TI" prefix is valid only at OSTI.
20. **Sources of availability** from which a copy of the document may be obtained; usually appear as abbreviations. (See information on following page.)
21. **Drop note** or explanatory statement.
22. **Abstract.**
23. **Subject descriptors.** Listed only if no abstract or only a brief statement is included.

Sample Citations

Report

18494 (DOE/ER/40438–T1) **[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report.** Haeberli, W. Phys. VI collaboration. **Wisconsin Univ., Madison (USA). Dept. of Physics.** [1989]. 12p. Sponsored by DOE Energy Research. DOE Contract FG02-88ER40438. Order Number DE89007246. **Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.**

This paper briefly discusses the Wisconsin test facility for storage cells; results of target tests; the new UHV...

Report Analytic

18500 (INIS-SU—69, pp. 30-32) **Transition energies in Ne-like ions. Correlation effects.** Vainshtejn, L.A. AN SSSR, Moscow. Fizicheskij Inst. 1988. (In Russian). **In *Experimental and theoretical physics. Collection.*** Order Number DE89780060. Available from NTIS (US Sales Only), PC A03/MF A01; INIS.

Kratkie Soobshcheniya po Fizike.; no. 6.

SILVER IONS/energy-level transitions; XENON IONS/energy-level transitions; CORRELATIONS; D STATES; E STATES;...

Journal Article

19055 **A theoretical and experimental investigation of long-pulse, electron-beam-produced rare gas plasmas.** Brake, M.L.; Repetti, T.E. (Energy Beam Interaction Lab. of the Dept. of Nuclear Engineering, Univ. of Michigan, Ann Arbor, MI (US)). ***IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science (USA),*** 16(5): 581-589 (Oct 1988). (CONF-881020–: Symposium on radiation physics, Sao Paulo, Brazil, October 3, 1988).

Visible emission spectroscopy (380-650 nm) has been performed on intense, electron beam (1 kA, 300 ns, 300 kV) produced Ar, Kr,...

Patent

18045 **Polarization of fast particle beams by collisional pumping.** Stearns, J.W. **To Dept. of Energy, Washington, DC. USA Patent 4,724,117.** 9 Feb 1988. Filed date 19 Oct 1984. vp. Available from Patent and Trademark Office, Box 9, Washington, DC 20232.

A method for polarizing a fast beam of particles by collisional pumping, comprising the steps of generating a beam...

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Report literature, usually identified by an alphanumeric identifier at the beginning of a citation, is available from the sources listed in the citation (see example of element 20 on page iii). Often the sources are listed as abbreviations. Corresponding addresses are provided at right from which documents with these abbreviations may be ordered. When "OSTI" is given, **DOE and DOE contractors may order these documents from OSTI.** (However, check with your library or information organization which may require that orders go through them to OSTI.) The public should order from NTIS or from one of the other agencies listed in the citation. To expedite processing, an order form is provided in the back of this publication. NOTE: The order numbers provide quicker access for report ordering. Use the order number where possible.

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Five indexes are provided for approaching the content of each issue of *Energy Research Abstracts*. Descriptions of entries in these indexes follow.

Corporate Author Index
The corporation, organization, or institution responsible for the issuance of the document is listed in this index. The entries are arranged alphabetically and provide the title and citation number of the reference. For example, the listing for the "Report" sample citation would appear as shown at right.

Wisconsin Univ., Madison (USA). Dept. of Physics
[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)
Wisconsin Univ., Madison (USA). Lab. of Genetics
Organization of the R chromosome region in maize: Final progress report, June 1, 1983–May 31, 1986, 15:18255 (R;US)

Personal Author Index
Each author's name listed on a document cited in this issue is indexed. An index entry provides title and citation number; for secondary and other names, a cross-reference is given to the primary author name where the full index entry is located.

Hadley, D.L., *See* Lee, A.D., 15:17651
Haeberli, W., [Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)

Subject Index
This index lists the main subject descriptors assigned to each record by indexing professionals. A secondary or qualifier term is used where necessary to describe materials, objects, and processes. Document titles may be enhanced with additional informative phrases where necessary. An excerpt from this index appears at right.

HYDROGEN ISOTOPES
See also DEUTERIUM
HYDROGEN 4
TRITIUM
Neutron-Rich Isotopes
Study on the strong neutron-rich nuclei of lightest elements, 15:18686 (RA;SU;In Russian)

Contract Number Index
DOE technical reports are listed by contract number. Each entry also provides the primary corporation or organization cited for that contract number. A typical entry is shown.

FG02-88ER40438 **Wisconsin Univ., Madison (USA). Dept. of Physics**
15:18494 DOE/ER/40438–T1
FG02-88ER60664 **Rogers and Associates Engineering Corp., Salt Lake City, UT (USA)**
15:17641 DOE/ER/60664–1

Report Number Index
Technical report literature is indexed by the alphanumerical identifier of the report. Patent documents and conferences are included for convenience. Each entry lists the citation number, the source of availability of the document, an indicator of presence at a GPO depository library, order number, and distribution category. A typical entry is:

DOE/ER/40438–
T1 15:18494 NTIS, PC A03/MF A01 - OSTI E 1.99: DE89007246 MF-411

Subject Contents

The subject content of *Energy Research Abstracts* is arranged as shown below. The two-digit and four-digit category numbers printed here illustrate the category number assignment used in the database records.* The following list includes all of the 39 first-level and the 308 second-level categories. Because each issue of *ERA* publishes citations only for those documents announced during the past semimonthly period, some subject categories may not be present in every issue.

Numerical Listing of Categories

01 COAL, LIGNITE, AND PEAT
- 03 Preparation
- 04 Processing
- 05 Products and By-Products
- 06 Properties and Composition
- 08 Waste Management
- 09 Environmental Aspects
- 10 Reserves, Geology, and Exploration
- 20 Mining
- 30 Transport, Handling, and Storage
- 40 Combustion
- 50 Economic, Industrial, and Business Aspects
- 60 Health and Safety
- 70 Legislation and Regulations

02 PETROLEUM
- 02 Reserves, Geology, and Exploration
- 03 Drilling and Production
- 04 Processing
- 05 Products and By-Products
- 06 Health and Safety
- 07 Economic, Industrial, and Business Aspects
- 08 Waste Management
- 09 Environmental Aspects
- 10 Legislation and Regulations
- 20 Transport, Handling, and Storage
- 30 Properties and Composition
- 50 Combustion

03 NATURAL GAS
- 02 Reserves, Geology, and Exploration
- 03 Drilling, Production, and Processing
- 04 Products and By-Products
- 05 Health and Safety
- 06 Economic, Industrial, and Business Aspects
- 07 Waste Management
- 08 Environmental Aspects
- 10 Legislation and Regulations
- 20 Transport, Handling, and Storage
- 30 Properties and Composition
- 40 Combustion

04 OIL SHALES AND TAR SANDS
- 02 Reserves, Geology, and Exploration
- 03 Drilling, Fracturing, and Mining
- 04 Oil Production, Recovery, and Refining
- 05 Properties and Composition
- 06 Products and By-Products
- 07 Health and Safety
- 08 Economic, Industrial, and Business Aspects
- 09 Waste Management
- 10 Environmental Aspects
- 20 Legislation and Regulations
- 30 Transport, Handling, and Storage
- 40 Combustion

05 NUCLEAR FUELS
- 01 Reserves, Exploration, and Mining
- 04 Feed Processing
- 05 Uranium Enrichment
- 07 Fuels Production and Properties
- 08 Spent Fuels Reprocessing
- 09 Transport, Handling, and Storage
- 10 Economic, Industrial, and Business Aspects
- 20 Waste Management
- 30 Environmental Aspects
- 40 Health and Safety
- 50 Safeguards, Inspection, and Accountability
- 60 Legislation and Regulations

07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY
- 01 Physical Isotope Separation
- 02 Radiation Sources
- 03 Isotopic Power Supplies
- 04 Economic, Industrial, and Business Aspects
- 05 Health and Safety

08 HYDROGEN
- 01 Production
- 02 Storage, Transport, and Handling
- 04 Economic, Industrial, and Business Aspects
- 05 Health and Safety
- 07 Products and By-Products
- 08 Properties and Composition
- 09 Environmental Aspects
- 10 Waste Management
- 20 Legislation and Regulations
- 30 Combustion

09 BIOMASS FUELS
- 07 Resources
- 08 Production
- 09 Processing
- 10 Properties and Composition
- 20 Combustion
- 30 Economic, Industrial, and Business Aspects
- 40 Transport, Handling, and Storage
- 50 Environmental Aspects
- 60 Health and Safety
- 70 Legislation and Regulations
- 80 Waste Management
- 90 Products and By-Products

10 SYNTHETIC FUELS
- 02 Production
- 03 Properties and Composition
- 04 Combustion
- 05 Transport, Handling, and Storage
- 06 Health and Safety
- 07 Economic, Industrial, and Business Aspects
- 08 Waste Management
- 09 Environmental Aspects
- 10 Legislation and Regulations
- 20 Products and By-Products

13 HYDRO ENERGY
- 01 Resources and Availability
- 02 Site Geology and Meteorology
- 03 Plant Design and Operation

*The numerical subject category scheme is used in the storage, retrieval, and manipulation of bibliographic information entered into DOE's data systems. Categories and definitions for the complete set of six-digit numbers are given in DOE/TIC-4584, *Energy Data Base: Subject Categories and Scope.*

04 Legislation and Regulations
05 Economic, Industrial, and Business Aspects
06 Environmental Aspects
07 Power-Conversion Systems
08 Health and Safety

14 SOLAR ENERGY
01 Resources and Availability
03 Economic, Industrial, and Business Aspects
04 Environmental Aspects
05 Solar Energy Conversion
06 Photovoltaic Power Systems
07 Solar Thermal Power Systems
08 Ocean Energy Systems
09 Solar Thermal Utilization
10 Solar Collectors and Concentrators
20 Heat Storage
30 Health and Safety
40 Legislation and Regulations

15 GEOTHERMAL ENERGY
01 Resources and Availability
02 Geology and Hydrology of Geothermal Systems
03 Geothermal Exploration and Exploration Technology
04 Legislation and Regulations
05 Economic, Industrial, and Business Aspects
06 Environmental Aspects
07 Products and By-Products
08 Geothermal Power Plants
09 Geothermal Engineering
10 Direct Energy Utilization
20 Geothermal Data and Theory
30 Health and Safety
40 Waste Management

16 TIDAL AND WAVE POWER
01 Resources and Availability
03 Legislation and Regulations
04 Economic, Industrial, and Business Aspects
05 Environmental Aspects
07 Tidal Power Plants
08 Wave Energy Converters
09 Health and Safety

17 WIND ENERGY
01 Resources and Availability (Climatology)
03 Legislation and Regulations
04 Economic, Industrial, and Business Aspects
05 Environmental Aspects
06 Wind Energy Engineering
07 Health and Safety

20 FOSSIL-FUELED POWER PLANTS
01 Power Plants and Power Generation
02 Waste Management
04 Health and Safety
05 Environmental Aspects
06 Economic, Industrial, and Business Aspects
07 Legislation and Regulations

21 NUCLEAR POWER PLANTS
01 Power Reactors, Nonbreeding, Light-Water Moderated, Boiling Water Cooled
02 Power Reactors, Nonbreeding, Light-Water Moderated, Nonboiling Water Cooled
03 Power Reactors, Nonbreeding, Graphite Moderated
04 Power Reactors, Nonbreeding, Otherwise Moderated or Unmoderated
05 Power Reactors, Breeding
06 Power Reactors, Auxiliary, Mobile, Package, and Transportable
07 Regulation and Licensing
08 Economics

22 NUCLEAR REACTOR TECHNOLOGY
01 Theory and Calculation
02 Components and Accessories
03 Fuel Elements
04 Control Systems
05 Environmental Aspects
06 Research, Test, and Experimental Reactors
07 Plutonium and Isotope Production Reactors
08 Propulsion Reactors
09 Reactor Safety

24 POWER TRANSMISSION AND DISTRIBUTION
01 Power Systems
02 Power System Networks, Transmission and Distribution
03 Power Transmission Lines and Cables
04 Health and Safety
05 Environmental Aspects
06 Legislation and Regulations
07 Economic, Industrial, and Business Aspects

25 ENERGY STORAGE
01 Magnetic
02 Compressed and Liquefied Gas
04 Capacitor Banks
05 Flywheels
06 Thermal
08 Chemical
09 Batteries
10 Economic, Industrial, and Business Aspects
20 Health and Safety
30 Environmental Aspects
40 Legislation and Regulations

29 ENERGY PLANNING AND POLICY
01 Energy Analysis and Modeling
02 Economics and Sociology
03 Environment, Health, and Safety
04 Energy Resources
05 Research, Development, Demonstration, and Commercialization
06 Nuclear Energy
07 Transport and Storage
08 Heat Utilization
10 Conservation
20 Supply, Demand, and Forecasting
30 Policy, Legislation, and Regulation
40 Fossil Fuels
50 Hydrogen and Synthetic Fuels
60 Electric Power
80 Consumption and Utilization
90 Unconventional Sources and Power Generation

30 DIRECT ENERGY CONVERSION
01 MHD Generators
02 EHD Generators
03 Thermoelectric Generators
04 Thermionic Converters
05 Fuel Cells
08 Miscellaneous Converters

32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION
01 Buildings
02 Transportation
03 Industrial and Agricultural Processes
06 Municipalities and Community Systems
09 Education and Public Relations

33 ADVANCED PROPULSION SYSTEMS
01 Internal Combustion Engines
02 External Combustion Engines
03 Electric-Powered Systems
04 Hybrid Systems
05 Flywheel Propulsion
06 Vehicle Design Factors
07 Emission Control
08 Alternative Fuels

35 ARMS CONTROL
01 Policy, Negotiations, and Legislation
02 Proliferation
03 Verification

36 MATERIALS
01 Metals and Alloys

02 Ceramics, Cermets, and Refractories
06 Other Materials

40 CHEMISTRY
01 Analytical and Separations Chemistry
02 Inorganic, Organic, and Physical Chemistry
04 Electrochemistry
05 Photochemistry
06 Radiation Chemistry
07 Radiochemistry and Nuclear Chemistry
08 Combustion, Pyrolysis, and High-Temperature Chemistry

42 ENGINEERING
02 Facilities, Equipment, and Techniques
04 Heat Transfer and Fluid Flow
05 Materials Testing
10 Combustion Systems
20 Mining and Underground Engineering
30 Marine Engineering
50 Power Cycles
60 Components, Electron Devices and Circuits

43 PARTICLE ACCELERATORS
01 Design, Development, and Operation
02 Beam Dynamics, Field Calculations, and Ion Optics
03 Auxiliaries and Components
04 Storage Rings

44 INSTRUMENTATION
01 Radiation Instrumentation
02 Radiation Effects on Instrument Components, Instruments, or Electronic Systems
04 Well Logging Instrumentation
05 Thermal Instrumentation
06 Optical Instrumentation
07 Geophysical and Meteorological Instrumentation
08 Miscellaneous Instrumentation

45 MILITARY TECHNOLOGY, WEAPONRY, AND NATIONAL DEFENSE
01 Chemical Explosions and Explosives
02 Nuclear Explosions and Explosives
03 Nuclear Explosion Detection
04 Nuclear and Radiological Warfare
05 Strategic Defense Initiative
06 Chemical and Biological

54 ENVIRONMENTAL SCIENCES
01 Environmental Sciences, Atmospheric
02 Environmental Sciences, Terrestrial
03 Environmental Sciences, Aquatic

55 BIOMEDICAL SCIENCES, BASIC STUDIES
01 Behavioral Biology
02 Biochemistry
03 Cytology
04 Genetics
05 Metabolism
06 Medicine
07 Microbiology
08 Morphology
09 Pathology
10 Physiological Systems
20 Public Health
30 Agriculture and Food Technology

56 BIOMEDICAL SCIENCES, APPLIED STUDIES
01 Radiation Effects
02 Thermal Effects
03 Chemicals Metabolism and Toxicology
04 Other Environmental Pollutant Effects

57 HEALTH AND SAFETY

58 GEOSCIENCES

64 PHYSICS I
01 Astrophysics and Cosmology
02 Atmospheric Physics
03 Atomic, Molecular, and Chemical Physics
04 Fluid Physics
50 High Energy Physics
51 Particle Interactions and Properties—Experimental
52 Particle Interactions and Properties—Theoretical
53 Particle Invariance Principles and Symmetries
54 Field Theory

65 PHYSICS II
10 Nuclear Physics
11 Experimental Techniques
12-20 Nuclear Properties and Reactions
30 Nuclear Theory
40 Radiation and Shielding Physics
50 Medical Physics
60 Condensed Matter Physics
61 Superconductivity
70 Theoretical and Mathematical Physics

70 FUSION ENERGY
01 Plasma Research
02 Fusion Power Plant Technology

99 GENERAL AND MISCELLANEOUS
01 Management
02 Mathematics and Computers
03 Information Handling
04 Law

CORPORATE AUTHOR INDEX

PERSONAL AUTHOR INDEX

SUBJECT INDEX

CONTRACT NUMBER INDEX

REPORT NUMBER INDEX

ORDER NUMBER CORRELATION

Alphabetical Listing of Categories

33 ADVANCED PROPULSION SYSTEMS
35 ARMS CONTROL
09 BIOMASS FUELS
56 BIOMEDICAL SCIENCES, APPLIED STUDIES
55 BIOMEDICAL SCIENCES, BASIC STUDIES
40 CHEMISTRY
01 COAL, LIGNITE, AND PEAT
30 DIRECT ENERGY CONVERSION
32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION
29 ENERGY PLANNING AND POLICY
25 ENERGY STORAGE
42 ENGINEERING
54 ENVIRONMENTAL SCIENCES
20 FOSSIL-FUELED POWER PLANTS
70 FUSION ENERGY
99 GENERAL AND MISCELLANEOUS
58 GEOSCIENCES
15 GEOTHERMAL ENERGY
57 HEALTH AND SAFETY
13 HYDRO ENERGY
08 HYDROGEN
44 INSTRUMENTATION
07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY
36 MATERIALS
45 MILITARY TECHNOLOGY, WEAPONRY, AND NATIONAL DEFENSE
03 NATURAL GAS
05 NUCLEAR FUELS
21 NUCLEAR POWER PLANTS
22 NUCLEAR REACTOR TECHNOLOGY
04 OIL SHALES AND TAR SANDS
43 PARTICLE ACCELERATORS
02 PETROLEUM
64 PHYSICS I
65 PHYSICS II
24 POWER TRANSMISSION AND DISTRIBUTION
14 SOLAR ENERGY
10 SYNTHETIC FUELS
16 TIDAL AND WAVE POWER
17 WIND ENERGY

Energy Research Abstracts

01 COAL, LIGNITE, AND PEAT

32036 (DOE/FE–0172P) **The cooperative research and development endeavor.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of Business Operations. Apr 1990. 23p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90010290. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Cooperative research programs from the Energy and Environmental Research Center, and Western Research Institute, are briefly described. (CBS)

0103 Preparation

Refer also to citation(s) 32083, 32084, 32312, 32313

32037 (DOE/PC/89904–T2, pp. 25-33) **Coal flotation and flocculation in the presence of humic acids.** Laivani, S.B. Southern Illinois Univ., Carbondale, IL (USA). Coal Extraction and Utilization Research Center. Apr 1989. In *High-sulfur coal research at the SIUC Coal Technology Laboratory. Quarterly progress report, January 1-March 31, 1989.* Order Number DE89013667. Available from NTIS, PC A06/MF A01.

The principle of coal cleaning using humic acid is as follows. Humic acid is an anionic polyelectrolyte which possesses a high density of carboxyl groups. The mechanism of coal depression involves the selective adsorption of humic acid on the hydrophobic coal through hydrophobic bonding. Pyrite and ash are hydrophilic in nature and will be separated from the carbonaceous part of the coal, thus resulting in a cleaner coal. Humic acid will also be used to aggregate coal particles. It is anticipated that the bonding mechanism could involve hydrogen bonding via the carboxyl group, and the formation of salt links. In the first quarter of the research phase the adsorption isotherms for humic acid adsorption were prepared. In order to enhance the ash flotation with simultaneous coal depression, in addition to humic acid, xanthate was also added to the coal slurries. Dramatic decrease in ash content was observed, while significant recovery of the original coal was accomplished in these flotation experiments.

32038 (DOE/PC/89904–T2, pp. 43-63) **Coal-water interactions and preparation of dewatered ultrafine clean coal.** Malhotra, V.M.; Zitter, R.N. Southern Illinois Univ., Carbondale, IL (USA). Coal Extraction and Utilization Research Center. Apr 1989. In *High-sulfur coal research at the SIUC Coal Technology Laboratory. Quarterly progress report, January 1-March 31, 1989.* Order Number DE89013667. Available from NTIS, PC A06/MF A01.

The mandate of this project is to understand the mechanism responsible for coal-water interactions and the ways water is held by ultrafine coal. In addition, the author is to develop a bench-scale dewatering technique based on heavy (< 15° API) crude oil derived fractions treatment. This quarter the major thrust of research was along three lines: (1) to design and construct a reflection type 9.5 GHz electron paramagnetic resonance (EPR) spectrometer with homodyne detection for the determination of the structure of water in coal pores, (2) to study the effect of low-temperature oxidation and/or weathering on the water holding capacity of a coal with two different particle sizes, and (3) to dewater deep cleaned micronized bituminous coal-water slurry by treating it with saturated hydrocarbons and/or petrolene and/or asphaltene. The design and construction of the EPR spectrometer is progressing satisfactorily, and the author expects the system to be operative for measurements soon. The DSC measurements at 100K < T < 320K on a lignite coal of particle sizes < 10 μm and < 1.1 mm showed that coal particle size has a strong effect on the water holding capacity of coal. However, what was surprising was that on subjecting the coal to low-temperature oxidation at 323K and 378K, the water holding capacity (especially of pore water) of lignite coal markedly decreased. The authors believes this may be due to the fusion of pore mouths when lignite coal is subjected to thermal treatment. Attempts were also made to dewater micronized bituminous coal-water slurry by treating it with pentane. Diffuse reflectance-FTIR measurements on the treated coal suggested that saturated hydrocarbons are not very effective agents for dewatering coal.

32039 (DOE/PC/89904–T2, pp. 65-73) **Electroosmotically enhanced dewatering/deliquoring of fine particle coal.** Sami, S.; Smith, J.G. Southern Illinois Univ., Carbondale, IL (USA). Coal Extraction and Utilization Research Center. Apr 1989. In *High-sulfur coal research at the SIUC Coal Technology Laboratory. Quarterly progress report, January 1-March 31, 1989.* Order Number DE89013667. Available from NTIS, PC A06/MF A01.

Tests aimed at determining the effectiveness of electroosmosis in dewatering ultrafine coals have been carried out. Effluent removal under gravity and under electroosmosis were measured and compared. The analysis included the determination of the energy expended as well as the number of uncharged water molecules removed per ion transferred during electroosmosis. The latter is being used in determining, quantitatively, process optimization. In order to verify and quantify predicted improvements in the effectiveness of electroosmosis with increased values of the zeta potential, three zeta potential-altering surfactants have been identified as candidates for testing their abilities to enhance electroosmotic dewatering by reducing the interfacial tension between water and coal.

32040 (DOE/PC/89904–T2, pp. 75-84) **Comminution employing liquid nitrogen pretreatments.** Yen, S.C.; Hippo, E.J. Southern Illinois Univ., Carbondale, IL (USA). Coal Extraction and Utilization Research Center. Apr 1989. In *High-sulfur coal research at the SIUC Coal Technology Laboratory. Quarterly progress report, January 1-March 31, 1989.* Order Number DE89013667. Available from NTIS, PC A06/MF A01.

The objective of this research is to enhance the grindability of coal using a liquid nitrogen pretreatment procedure. Such a pretreatment will increase the brittleness of coal and introduce interfacial cracking between coal matrix, pyritic compound, and other minerals. As a result, the production of finer coal particles, as well as a potential liberation of pyrite, can be achieved in a rather mild grinding condition. It is anticipated that a much narrower particle size distribution can also be obtained. Such a feature will be very useful in the handling of coal, such as the separation of pyrite from coal, the dewatering of coal, and the agglomeration of coal particles. The present efforts have been concentrated on the preliminary studies leading to the establishment of a program of more comprehensive research into ultrafine coal grinding. It was found that after soaking a coal sample in a liquid nitrogen environment, fractures developed through the coal matrix, as well as along the interface between coal and pyrite. Moreover, the larger cracks tend to separate the pyrite region from the surrounding coal matrix. The micro-indentation method was applied to a sample to study the fracture resistance of coal upon loading. It was found that a well-defined fracture pattern was developed. This indicates that the characterization of fracture of coal using the indentation technique is applicable. Grinding using a ball mill was conducted on the untreated coal at different time durations. It was found that a grinding time beyond 10 min in duration did not further reduce the particle sizes nor improve the particle size distribution curve to a narrower band. Such a study will also be applied to the coal sample receiving liquid nitrogen pretreatment to determine the optimal grinding time.

32041 (DOE/PC/89904–T10) **High-sulfur coal research at the SIUC [Southern Illinois University at Carbondale] Coal Technology Laboratory: Quarterly progress report, January 1–March 31, 1990.** Southern Illinois Univ., Carbondale, IL (USA). Coal Extraction and Utilization Research Center. Apr 1990. 52p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC22-89PC89904. Order Number DE90010972. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Research on high-sulfur coal through the Coal Technology Laboratory program at Southern Illinois University at Carbondale (SIUC) is divided into three general categories: coal science, coal preparation, and coal utilization. In the category of coal science, the study, of the reactivity of whole coals, selected pure maceral fractions, and cleaned coal products, is in its third year. In the coal preparation area, work has been completed for six projects: microbial desulfurization; coal-water interactions; a study of the energetics of C-S bond breakup reactions in radical ions derived from coal model compounds; a study of the modification of coal surfaces with methyl radicals; and a study of coal flotation and flocculation in the presence of humic acid. Three projects are underway: electro-osmotically enhanced dewatering/deliquoring of fine-particle coal; comminution employing liquid nitrogen pretreatments; and chlorine removal from coal. The coal utilization category has two projects in progress: investigation of a small-user applications of fine-particle coal, a modeling technique which divides the pulse combustor into different cells has resulted in a stable computational procedure; and corona-enhanced absorption of SO_2/NO_x, modeling of flue gas plasma in a dielectric-barrier discharge with uv-irradiation was accomplished. The completed project is a study of thermal methods for healing defects in protective oxide films on alloys.

32042 (DOE/PC/89904–T11) **High-sulfur coal research at the SIUC Coal Technology Laboratory: Quarterly progress report, January 1–March 31, 1990.** Southern Illinois Univ., Carbondale, IL (USA). Coal Extraction and Utilization Research Center. Apr 1990. 55p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC22-89PC89904. Order Number DE90011037. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Research on high-sulfur coal through the Coal Technology Laboratory program at Southern Illinois University at Carbondale (SIUC) is divided into three general categories: coal science, coal preparation, and coal utilization. On study is currently underway in coal science on the reactivity of whole coals, selected pure maceral fractions, and cleaned coal products. In the coal preparation category, three projects are currently underway: a mechanistic study of the removal of chlorine from coal; electro-osmotically enhanced dewatering/deliquoring of fine-particle coal;and comminution employing liquid nitrogen pretreatments. The coal utilization category has two projects in progress: an investigation small-user applications of fine-particle coal, a modeling technique which divides the pulse combustor into different cells has resulted in a stable computational procedure; and corona-enchanced absorption of SO_2/NO_x, modeling of flue gas plasma in a dielectric-barrier discharge with uv-irradiation. Simulations were carried out using the model.

32043 (GAO/RCED–89-169FS) **Fossil fuels: Status of DOE-funded clean coal technology projects as of March 19, 1989.** General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div. Jun 1989. 15p. Available from US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877 (USA).

This paper provides a detailed discussion on the status of nine demonstration projects that the Department of Energy has funded under the Clean Coal Technology program. Seven of the nine funded clean coal technology projects were not progressing as planned. DOE does not yet know the effect these delays will have on estimated project completion dates and its share of total project costs. Specifically, the seven projects were experiencing coordination, equipment, and financing problems that caused delays in completing project phases, cost overruns, and proposed project modifications.

0104 Processing

Refer also to citation(s) 32041, 32042, 32266, 33189

32044 (CONF-900546–1) **Melting of iron-aluminide alloys.** Sikka, V.K. Oak Ridge National Lab., TN (USA). [1990]. 12p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. From 4. conference on fossil energy materials; Oak Ridge, TN (USA); 15-17 May 1990. Order Number DE90011068. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The melting of Fe_3Al-based alloys at the Oak Ridge National Laboratory (ORNL) and commercial vendors is described. The melting processes evaluated includes are melting, air-induction melting (AIM), vacuum-induction melting (VIM), and electroslag remelting (ESR). The quality of the ingots studied are base on internal soundness and the surface finish obtained. The ingots were analyzed for recovery of various elements during melting. The impurity levels observed in the alloys by various melting processes were compared. Recommendations are made for viable processes for commercial melting of these alloys. 1 ref., 5 figs., 3 tabs.

32045 (CONF-900789–1) **HAZ liquation cracking behavior in newly developed lean 316 stainless steels.** Lundin, C.D. (Tennessee Univ., Knoxville, TN (USA). Dept. of Materials Science and Engineering); Qiao, C.Y.P.; Goodwin, G.M.; Swindeman, R.W. Oak Ridge National Lab., TN (USA). [1990]. 40p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. From ASME PVP conference; Nashville, TN (USA); 17-21 Jul 1990. Order Number DE90009409. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The development of an advanced austenitic alloy to meet the needs of new power generation units(650°C–35MPa) is being aggressively pursued in Japan and Europe and in the US, the DOE through the AR&TD Fossil Energy Program managed by ORNL,has extensive studies underway. The Basic tenets of alloy design involve long time strength and creep rupture properties metallurgical stability, corrosion resistance and fabricability including weldability. A modified 316 stainless steel (lean 316 stainless steel) has been recently developed at ORNL based upon standard composition of materials used in elevated temperature service. The basic modification is effected by using carbide forming and solid solution elements plus a thermo-mechanical treatment consistent with supperheater tube production procedures to improve the elevated temperature properties. Researchers at ORNL have shown that the added strength is achieved through the precipitation of fine carbides, nitrides, or phosphides that stabilize dislocation networks. 8 figs., 4 tabs.

32046 (DOE/FE–0178P) **Coal Liquefaction Program: Fiscal year 1990, Summary program plan.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of the Deputy Assistant Secretary for Coal Technology. Sep 1989. 30p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90010314. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The overall goal of the Coal Liquefaction Program of the Office of Coal Technology (OCT) is to develop the scientific and engineering knowledge base with which industry can bring economically competitive and environmentally acceptable advanced technology for manufacturing synthetic liquid fuels from coal into the marketplace when needed. The technical goal of the Coal Liquefaction Program is to seek advanced and innovative improvements over the state-of-the-art processes for coal liquefaction that can utilize all major parts of the US coal resource base. A technology description and discussion of program goals and strategy is provided in this report. 2 figs.

32047 (DOE/MC/05564–2815) **Trend analysis of coal gasification product yields in an entrained flow reactor: Final report.** Celik, I.; Chattree, M. West Virginia Univ., Morgantown, WV (USA). Dept. of Mechanical and Aerospace Engineering. Oct 1989. 54p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AH21-88MC05564. Order Number DE90000478. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The coal gasification experiments performed by Bissett (1986) under a wide range of residence time, reaction temperatures and pressures form an excellent data base for either verification or predictive computational models. The experiments have been conducted on the METC advanced gasification facilities reactor. For the steam tests via the primary stream a mixture of pulverized coal and conveying Argon, and via the secondary stream (the annular region) a mixture of steam and Argon are introduced into the reactor. For the carbon dioxide tests, a mixture of pulverized coal and conveying Argon is introduced into the reactor via the primary stream; reactant CO_2 is introduced into the reactor via the secondary stream. 8 refs., 20 figs., 9 tabs.

32048 (DOE/MC/11076–2795) **Jet fuels potential of liquid by-products from the Great Plains Gasification Project.** Smith, E.B.; Guffey, F.D.; Nickerson, L.G. Western Research Inst., Laramie, WY (USA). Jan 1988. 41p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-86MC11076. Order Number DE90000459. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Three liquid by-products from the Great Plains Gasification Project–tar oil, crude phenols, and naphtha–were evaluated as potential sources of military jet fuels. Each was used as a feedstock for catalytic hydrogenation experiments to characterize its hydrogenation behavior and to determine the properties of intermediate products at various levels of process severity. Shell 424 Ni–Mo catalyst was employed in all experiments. Tar oil experiments were conducted at 2000 psig, with liquid hourly space velocities (LHSV) of 1.00, 0.50, or 0.33, hydrogen feed ratios from 6000 standard cubic feet per barrel (scfb) to 16,000 scfb, and at temperatures from 650°F (343°C) to 750°F (399°C). Phenols experiments were conducted at 2000 psig, LHSV of 0.50 or 1.00, with a hydrogen feed ratio of 6000 scfb and at temperatures ranging from 550°F (289°C) to 650°F (343°C). Naphtha experiments were conducted at 500 psig, with LHSV of 1.00, a hydrogen feed ratio of 1500 scfb, and temperatures of 300°F (149°C) to 500°F (260°C). Five products were collected, three of which were sufficiently saturated to serve as sources for preparation of test fuel samples. 3 refs., 19 tabs.

32049 (DOE/MC/21353–2805) **Assessment of membrane gas separation applications to METC [Morgantown Energy Technology Center] supported techniques: Final report.** Poku, J.A.; Plunkett, J.E. EG and G Washington Analytical Services Center, Inc., Morgantown, WV (USA). Aug 1989. 51p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-85MC21353. Order Number DE90000465. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The objectives of this study were to catalog commercial and developmental membrane applications for gas separation, identify the status and the developers of each, and to identify how these separation processes might be applied for removal of trace contaminants or purification of gases generated by coal processing. 55 refs., 10 figs., 9 tabs.

32050 (DOE/MC/22065–2809) **Low-temperature, sulfur-tolerant homogeneous catalysts for the water-gas shift reaction: Final report.** Wilson, R.B. Jr.; Asaro, M.F.; Crawford, E.J.; Wood, B.J.; Laine, R.M.; Schwaar, R.H. SRI International, Menlo Park, CA (USA). Dec 1989. 107p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-85MC22065. Order Number DE90000441. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Coal gasification in conjunction with the water-gas shift reaction represents a significant resource for the production of hydrogen, a gas of considerable industrial value. Current industrial water-gas shift reaction (WGSR) processes are operated in two stages: a high temperature shift (HTS) stage operating at about 350°C over sulfur-tolerant catalysts, followed by a low temperature shift (LTS) stage operating at about 250°C over a sulfur-intolerant catalyst. Several reports in the literature suggest that homogeneous catalysis of WGS is highly active at LT and sulfur-tolerant. Catalysts active at temperatures as low as 60°C are reported to remain active in the presence of large sulfur concentrations. However, these studies were conducted in batch reactors with activities measured far from equilibrium. Those conditions are very different from industrial conditions of continuous operation close to equilibrium. The purpose of this project was to evaluate these homogeneous WGS catalysts under more industrially relevant conditions and to preliminarily compare the economics of a process based on high-activity, LT, sulfur-tolerant, homogeneous WGS catalysts to a process based on current industrial practice. Several transition element catalysts were screened. 98 refs., 11 figs., 23 tabs.

32051 (DOE/MC/24267–2837) **Development of an advanced, continuous mild gasification process for the production of co-products: Quarterly technical progress report, October–December 1989.** Ness, R.O. Jr. North Dakota Univ., Grand Forks, ND (USA). Energy and Environmental Research Center. Feb 1990. 15p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-87MC24267. Order Number DE90011187. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Construction is nearly completed on the 100-lb/hr Process Development Unit (PDU). All major equipment except the superheater has arrived. Piping, wiring, and instrument installation are in their final stages. Process control schemes have been laid out and are approximately 50% complete. Shakedown of finished systems is in progress. Start-up liquids for the venturis and sieve tower have been evaluated and will be tested during the next quarter. Char and coal upgrading studies are continuing. 1 fig., 6 tabs.

32052 (DOE/PC/88917–T4) **A new approach in ultrapurification of coal by selective flocculation: Quarterly report.** Moudgil, B.M. Florida Univ., Gainesville, FL (USA). Mineral Resources Research Center. Mar 1990. 16p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88917. Order Number DE90011036. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The mathematical and computational model developed for predicting optimum selectivity achievable with a polymer has been successfully verified experimentally. Adsorption density of polymer SF 362 on coal and coal pyrite was measured using the depletion method. Values of Y_R (active sites ratio) and Θ (fractional surface coverage) were computed using the adsorption data. The mathematical model predicted a low selectivity in separating coal pyrite from coal which was also verified by selective flocculation tests. FTIR surface area and size distribution analysis indicated that mineral matter associated with both coal and coal pyrite samples can adversely affect the performance of the polymer in the selective flocculation process. Adsorption tests are in progress to identify experimental conditions (dispersant, pH, flocculent) yielding a higher value of Y_R so that the desired separation of coal pyrite from coal can be obtained. 2 refs., 8 figs., 3 tabs.

32053 (DOE/PC/88935–T5) **Inhibition of retrogressive reactions in coal/petroleum co-processing: Quarterly technical progress report, December 1, 1989–February 28, 1990.** Schobert, H.H.; Tomic, J. Pennsylvania State Univ., University Park, PA (USA). Coll. of Earth and Mineral Sciences. Mar 1990. 31p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88935. Order Number DE90011004. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The overall objective of this project is to develop a fundamental understanding of the reactions occurring at the onset of coke formation during co-processing of coals with petroleum residua. Specific objectives include examination of chemical components, or groups of components, in coals and petroleum feedstocks to quantify and rank the effects of these components on retardation or enhancement of coke formation. The work involves bench scale reactions in microautoclaves, supplemented by studied of the carbonaceous residues by such techniques as diffuse reflectance Fourier transform infrared spectroscopy and C nuclear magnetic resonance spectrometry. This quarter work focused on the identification of solvation and dispersion effects. Microautoclaves testing of mixtures of model compounds and coals was continued in order to identify those features of model compound structures that are important in solvating the coals 3 refs., 3 figs.

32054 (DOE/PC/89904–T2, pp. 15-23) **Mechanistic study of chlorine removal from coal by high-temperature leaching.** Chen, Hanlin; Muchmore, C.B. Southern Illinois Univ., Carbondale, IL (USA). Coal Extraction and Utilization Research Center. Apr 1989. In *High-sulfur coal research at the SIUC Coal Technology Laboratory. Quarterly progress report, January 1-March 31, 1989.* Order Number DE89013667. Available from NTIS, PC A06/MF A01.

The objectives of this research are to: (1) continue the experimental investigation of removal of chlorine from coal using high-temperature leaching techniques, (2) understand the mechanisms involved in the leaching of chlorine from coal, and (3) develop a mathematical model which can be used to correlate the data and to describe the performance of the process. During this quarter, hot water leaching experiments were performed on a coal sample obtained from the Illinois Coal Development Board Sample Bank. The sample (IBCSP No. 9) has been recently added to the Sample Bank, and is the first high chlorine content (0.42%) coal to

become available from that source. Kinetic leaching studies employing different particle sizes of this coal have been carried out; chlorine removal in excess of 50% has been observed for the smaller particle sizes. This coal has also been studied in the tube furnace system, and has exhibited chlorine losses approached 80% after 48 hours at 300 C. Chlorine balances performed on runs using the tube furnace have shown accountabilities in excess of 90%.

32055 (DOE/PC/89904–T2, pp. 35-36) **Microbial removal of organic sulfur from coal (bacterial degradation of sulfur containing heterocyclic compounds).** Klubek, B. Southern Illinois Univ., Carbondale, IL (USA). Coal Extraction and Utilization Research Center. Apr 1989. In *High-sulfur coal research at the SIUC Coal Technology Laboratory. Quarterly progress report, January 1-March 31, 1989.* Order Number DE89013667. Available from NTIS, PC A06/MF A01.

The presence of substantial levels of sulfur in coal is a major source of air pollution, and considerable efforts are being made to devise a cost-effective way of removing the sulfur. One method is to mutate a laboratory species, Escherichia coli, an organism which is genetically well-understood and whose pathways for the metabolism of sulfur-containing amino acids have been extensively investigated. Such thiophene degraders can be genetically analyzed and the genes involved can be cloned in order to amplify their products. An alternative approach is the development of naturally occurring bacteria capable of thiophene desulfurization. Characterization of the degradation of model compounds, enhancement of the desulfurization potential of the isolated strains via mutagenesis, and studies with crushed coal will comprise the approach used in this study. The screening of soil isolates for the potential to desulfurize thiophenic and other sources of organic sulfur will identify the best strains for the microbial removal of organic sulfur from coal. Ultimately, the genes responsible for thiophene degradation by the isolated strains will be transferred to and E. coli strain, creating a single organism capable of degrading a broad spectrum of thiophene compounds.

32056 (DOE/PC/89904–T2, pp. 37-41) **Genetic approach to microbial coal desulfurization.** Clark, D.P. Southern Illinois Univ., Carbondale, IL (USA). Coal Extraction and Utilization Research Center. Apr 1989. In *High-sulfur coal research at the SIUC Coal Technology Laboratory. Quarterly progress report, January 1-March 31, 1989.* Order Number DE89013667. Available from NTIS, PC A06/MF A01.

Naturally occurring sulfur bacteria such as Thiobacillus and Sulfolobus can remove inorganic sulfur from coal. The authors hopes to contribute to the development of genetically engineered bacteria which can remove the organic sulfur effectively. A process which used an appropriate mixture of bacteria to remove both types of sulfur from coal should be inexpensive and produce harmless waste products. He is cloning genes from an Escherichia coli mutant with the ability to oxidize thiophene derivatives in order to enhance this ability. He is also cloning plasmid-borne genes from wild dibenzothiophene degrading strains. By putting together the best genes from various organisms he hopes to construct an efficient desulfurizing bacterium.

32057 (DOE/PC/89904–T2, pp. 89-100) **Modification of coal surfaces with methyl radicals.** Smith, G.V.; Wiltowski, T.; Myszka, E. Southern Illinois Univ., Carbondale, IL (USA). Coal Extraction and Utilization Research Center. Apr 1989. In *High-sulfur coal research at the SIUC Coal Technology Laboratory. Quarterly progress report, January 1-March 31, 1989.* Order Number DE89013667. Available from NTIS, PC A06/MF A01.

Experiments were conducted on IBCSP No. 5 coal with mixtures of methane and oxygen with and without electric discharge generated in-stream by an Electro-Technic Products model BD-10A Generator. Yields of BTX (benzene, toluene, and the xylenes), medium hydrocarbons (C_7-C_{10}), and naphthalenes were measured and found to be only modestly influenced by electric discharge but significantly influenced by temperature. The yields of both BTX and medium hydrocarbons go through maxima at 500 C, whereas the yield of naphthalenes goes through a minimum at this temperature. This inverse correlation between the yields of the naphthalenes and the BTX and medium hydrocarbons suggests a relationship in which BTX and medium hydrocarbons may be fragments or rearrangement products from the naphthalenes.

32058 (DOE/PC/90015–T1-Vol.6) **Production of jet fuels from coal derived liquids: Volume 6, Preliminary analysis of upgrading alternatives for the Great Plains liquid by-product streams: Interim report, March 1987–February 1988.** Fleming, B.A. (Amoco Oil Co., Naperville, IL (USA). Research and Development Dept.); Fox, J.D.; Furlong, M.W.; Masin, J.G.; Sault, L.P.; Tatterson, D.F.; Fornoff, L.L.; Link, M.A.; Stahlnecker, E.; Torster, K. Amoco Oil Co., Naperville, IL (USA). Research and Development Dept. Sep 1988. 305p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC90015. (AFWAL-TR–87-2042-Vol.6). Order Number DE90011005. Available from NTIS, PC A14/MF A01 - OSTI.

Amoco and Lummus Crest have developed seven cases for upgrading by-product liquids from the Great Plains Coal Gasification Plant to jet fuels, and in several of the cases, saleable chemicals in addition to jet fuels. The analysis shows that the various grades of jet fuel can be produced from the Great Plains tar oil, but not economically. However, the phenolic and naphtha streams do have the potential to significantly increase (on the order of $10–15 million/year) the net revenues at Great Plains by producing chemicals, especially cresylic acid, cresol, and xylenol. The amount of these chemicals, which can be marketed, is a concern, but profits can be generated even when oxygenated chemical sales are limited to 10 percent of the US market. Another concern is that while commercial processes exist to extract phenolic mixtures, these processes have not been demonstrated with the Great Plains phenolic stream. 9 refs., 24 figs., 14 tabs.

32059 (DOE/PC/90015–T1-Vol.9) **Production of jet fuels from coal derived liquids: Volume 9, Results of bench-scale testing and pilot plant testing: Interim report, February 1988–March 1989.** Furlong, M.; Fox, J.; Masin, J. Amoco Oil Co., Naperville, IL (USA). Research and Development Dept. Jun 1989. 52p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC90015. (AFWAL-TR–87-2042-Vol.9). Order Number DE90011006. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Amoco Oil Company has conducted bench- and pilot plant-scale experiments to produce jet fuels from the tar oil from the Great Plains Coal Gasification Plant in Beulah, North Dakota. Experiments show that the hydroprocessing conditions recommended in Task 1 are not severe enough to saturate the aromatics in the tar oil to meet jet fuel specifications. Alternatives were investigated. Jet fuel specifications can be achieved when the tar oil is: hydrotreated in an expanded-bed hydrotreater to lower aromatics and heteroatom content; the effluent is then hydrotreated in a second, fixed bed hydrotreater; and, finally, the 550°F boiling fraction from the two hydrotreaters is hydrocracked to extinction. The process was verified by pilot-plant production of 2 barrels of JP-8 turbine fuel, which met all but the flash point specification for JP-8. In addition, small samples of JP-4, JP-8, and high-density fuel were produced as a part of Task 2. 13 figs., 21 tabs.

32060 (DOE/PC/90015–T1-Vol.12) **Production of jet fuels from coal-derived liquids: Volume 12, Preliminary process design and cost estimate and production run recommendation: Final report, March 1989–December 1989.** Furlong, M. (Amoco Oil Co., Naperville, IL (USA). Research and Development Dept.); Fox, J.; Masin, J.; Stahlnecker, E., Schreiber, G.; Klein, R. Air Force Wright Research and Development Center, Wright-Patterson AFB, OH (USA). Aero Propulsion and Power Lab. Dec 1989. 384p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC90015. (AFWAL-TR–87-2042-Vol.12). Order Number DE90011007. Available from NTIS, PC A17/MF A01 - OSTI.

A preliminary design for the production of JP-8 jet fuel and other salable products from the Great Plains by-products is given. The design incorporates experimental results from Tasks 2 and 3 with the scoping design from Task 1. The experimental results demonstrated the need for more severe hydrotreating conditions to convert the tar oil to jet fuel than was estimated in Task 1. As a result, capital costs for the revised design are significantly higher and the plant is less profitable than estimated in the Task 1 work. The increase in capital costs is offset somewhat by a higher phenol

value in the current market. Refined estimates for the cost of an aromatics recovery unit preclude its economical construction in the new estimate, consequently the revised product slate includes no BTX. Recommendations are given for a 10,000 barrel production run. No commercial domestic facility exists which can provide suitable expanded-bed hydrotreating facilities for a production run of this size. However, an alternative approach using hot filtration and dilute fixed-bed hydrocracking followed by product fractionation and extinctive hydrotreating of the heavy products is recommended. Commercial domestic facilities which might reasonably accommodate this scheme are listed. 6 refs., 8 figs., 11 tabs.

32061 (DOE/PC/90015–T4) **Production of jet fuel from coal-derived liquids: Report No. 16: Quarterly technical progress report, second quarter FY 1988, January 1, 1988–March 31, 1988.** Furlong, M.W.; Fox, J.D.; Masin, J.G.; Soderberg, D.J. Amoco Oil Co., Naperville, IL (USA). Research and Development Dept. [1990]. 76p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC90015. Order Number DE90011008. Available from NTIS, PC A05/MF A01 - OSTI.

Amoco and Lummus Crest, under a contract with the United States Department of Energy, are evaluating the process options and economics for upgrading the naphtha, crude phenols, and tar oil by-products from the Great Plains Coal Gasification Plant to jet fuels and other salable products. Conceptual processing schemes for maximizing the production of Grades JP-4, JP-8, and high-density (JP-8X) jet fuels, for maximizing profits, and for profitable production of each of the three jet fuels from the by-product liquids have been developed. Economic analyses of the designs show that jet fuel can be produced from the by-products, but not economically. However, jet fuel production could be subsidized profitably by processing the phenolic and naphtha streams to cresols, phenols, BTX, and other valuable chemical by-products. Uncertainties in the studies are marketability of the chemical by-products, replacement fuel costs, and viable schemes to process the phenol stream, among others. 8 figs., 2 tabs.

32062 (DOE/PC/90015–T5) **Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 17, April 1–June 30, 1988.** Furlong, M.W.; Fox, J.D.; Masin, J.G.; Soderberg, D.J. Amoco Oil Co., Naperville, IL (USA). Research and Development Dept. 1988. 23p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC90015. Order Number DE90011009. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Amoco and Lummus Crest, under a contract with the United States Department of Energy, are evaluating the process options and economics for upgrading the naphtha, crude phenols, and tar oil by-products from the Great Plains Coal Gasification Plant to jet fuels and other salable products. Task 1 of the work, in which processes to produce each of the three jet fuels, JP-4, JP-8, and JP-8X, were designed, has been completed. The formal Task 1 report should issue next quarter. Task 2 work was initiated this quarter. In Task 2, process conditions for producing jet fuel from the Great Plains tar oil stream will be verified and samples of each of the three jet fuels will be produced. Experimental work shows that the hydrotreating conditions specified in Task 1 will not convert sufficient aromatics in the tar oil to produce jet fuel. Alternative schemes have been proposed and are being tested in the laboratories at Amoco Research Center. The simplest of these schemes, in which the heavy ends from the hydrotreater are recycled to extinction, was tested and proved infeasible. A second stage, fixed bed hydrotreater will be added to the process along with the expanded bed, first-stage hydrotreater and the hydrocracker specified in the Task 1 design. Future work will include additional experiments to specify the best process configuration and production of samples of each of the three grades of jet fuel. 6 figs., 7 tabs.

32063 (DOE/PC/90015–T6) **Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 23, July 1–September 30, 1988.** Furlong, M.W.; Fox, J.D.; Masin, J.G. Amoco Oil Co., Naperville, IL (USA). Research and Development Dept. 1988. 23p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC90015. Order Number DE90011010. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Amoco and Lummus Crest, under a contract with the United States Department of Energy, are evaluating the process options and economics for upgrading the naphtha, crude phenols, and tar oil by-products from the Great Plains Coal Gasification Plant to jet fuels and other salable products. Analytical characterizations of these three by-products indicate the range of products that can be manufactured from each, and potential problems which could be encountered during refining. These characterizations, along with limited experimental data and Amoco's proprietary process models, were used to design conceptual processing schemes for maximizing the production of Grades JP-4, JP-8, and high-density (JP-8X) jet fuels from the by-product liquids. Conceptual designs have been completed and a case for profitable production of JP-8 has been selected for experimental testing and preliminary design in the later phases of the contract. Experimental work to date has shown that the tar oil stream requires substantially more severe processing than the preliminary design estimates indicated. A new design basis is now being tested and samples of JP-4, JP-8, and JP-8X are in production, based on that new, more severe processing scheme. Six barrels of tar oil have been hydrotreated according to the first step of the processing scheme and will be used to produce barrel quantities of JP-8. 2 refs., 2 figs.

32064 (DOE/PC/90015–T7) **Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 25, October 1–December 31, 1988.** Furlong, M.W.; Fox, J.D.; Masin, J.G. Amoco Oil Co., Naperville, IL (USA). Research and Development Dept. 1988. 36p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC90015. Order Number DE90011011. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Amoco and Lummus-Crest, under a contract with the United States Department of Energy, are evaluating the process options and economics for upgrading the naphtha, crude phenols, and tar oil by-products from the Great Plains Coal Gasification Plant to jet fuels and other salable products. Analytical characterizations of these three by-products indicate the range of products that can be manufactured from each and potential problems which could be encountered during refining. These characterizations, along with limited experimental data and Amoco's proprietary process models, were used to design conceptual processing schemes for maximizing the production of Grades JP-4, JP-8, and high-density (JP-8X) jet fuels from the by-product liquids. Conceptual designs have been completed and a case for profitable production of JP-8 has been selected for experimental testing and preliminary design in the later phases of the contract. Samples of JP-4, JP-8, and JP-8X aviation turbine fuels have been manufactured from the Great Plains tar oil. Larger samples of JP-8 are nearly completed. Specification of a design basis for profitable production of JP-8 is under way. 5 figs., 4 tabs.

32065 (DOE/PC/90015–T8) **Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 29, January 1–March 31, 1989.** Furlong, M.W.; Fox, J.D.; Masin, J.G. Amoco Oil Co., Naperville, IL (USA). Research and Development Dept. 1989. 13p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC90015. Order Number DE90011012. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Amoco and Lummus-Crest, under a contract with the United States Department of Energy, are evaluating the process options and economics for upgrading the naphtha, crude phenols, and tar oil by-products from the Great Plains Coal Gasification Plant to jet fuels and other salable products. Analytical characterizations of these three by-products indicate the range of products that can be manufactured from each and potential problems which could be encountered during refining. These characterizations, along with limited experimental data and Amoco's proprietary process models, were used to design conceptual processing schemes for maximizing the production of Grades JP-4, JP-8, and high-density (JP-8X) jet fuels from the by-product liquids. Conceptual designs have been completed and a case for profitable production of JP-8 has been selected for experimental testing and preliminary design. Samples of JP-4, JP-8, and JP-8X aviation turbine fuels have been manufactured from the Great Plains tar oil. Larger samples of JP-8 have also been produced and shipped to the US Air Force for further

testing. Lummus-Crest Inc. is now completing a preliminary process design for the profitable production of JP-8 and has made recommendations for a production run to produce larger quantities of JP-8. 2 figs., 3 tabs.

32066 (EGG-M-89151) **Acoustical and dynamic mechanical characterization of fiber-matrix interface bonds in ceramic composites.** Lott, L.A.; Kunerth, D.C. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 7p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC07-76ID01570. (CONF-890770-10: 16. annual review of progress in quantitative nondestructive evaluation, Brunswick, ME (USA), 23-28 Jul 1989). Order Number DE90010949. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Ceramic matrix composites presently being developed are potentially well suited for high temperature structural applications. The character of the fiber-matrix bond plays a significant role in determining the fracture toughness of the material and thus its performance. Increased toughness is achieved by phenomena such as interface debonding and fiber slip or pull-out, which improve material toughness by increasing the energy required to propagate a crack. In a bond that is too weak, the toughening mechanisms are not significant. However, a bond that is too strong permits a crack to propagate directly through a fiber-matrix interface without being significantly affected, resulting in brittle fracture. As a result, care is required in the manufacture of these materials to achieve optimum fiber-matrix bonding. The objective of this work is to develop and evaluate techniques to nondestructively characterize the fiber-matrix interface bonds. The techniques being investigated include ultrasonic velocity and attenuation, acousto-ultrasonic response, and internal dynamic mechanical damping. 7 refs., 5 figs., 1 tab.

32067 (EGG-M-89221) **Reactors for scaling-up coal bioprocessing.** Andrews, G. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 17p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC07-76ID01570. (CONF-890582-4: EPRI symposium on biological processing of coal and coal-derived substances, Palo Alto, CA (USA), 16-17 May 1989). Order Number DE90010988. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Although considerable research has been done on the biochemistry and microbiology of coal bioprocessing, relatively little attention has been paid to the type of reactor in which these processes could be carried out on a commercial scale. This is unfortunate for two reason. First, no bioreactors currently exist for large-volume low value solid products like coal. Second, the cost of building the reactor will be major of the economic feasibility of these processes must await the selection, optimization and first-stage scale-up of the reactor. The reactor must provide, at minimum cost, an environment in which the highest possible number of cells can work at their maximum specific rates. This implies a high concentration of finely ground coal and rapid transfer of nutrients (including O_2) and products to and from the coal surface. Unfortunately these are mutually exclusive without a large investment in energy for mixing. Some cell recycle will be essential to keep the microbial concentration high without the cost of buying nutrients to grow new microorganisms. Possible bioreactor types, including slurry reactors, "heap" reactors and fluidized beds will be discussed along with new problems arising from the possible use of genetically engineered organisms. 18 refs., 4 figs., 1 tab.

32068 (EUR-12348-EN) **Reducing sulphur in coke.** British Coal Corp., Stoke Orchard (UK). Coal Research Establishment. 1990. 90p. Available from Commission of the European Communities, Luxembourg.

The presence of sulphur in the blast-furnace burden has a detrimental effect on the economics of the ironmaking process. There are three basic areas where sulphur reduction could take place, during charge preparation, during carbonisation and in the post-carbonisation stage. A review of the literature indicated that several methods could be applicable to reducing the sulphur content of metallurgical cokes and some of these have been examined. With the coal preparation methods, such as specific gravity separations, magnetic separation with and without magnetic enhancement and chemical desulphurisation, it was concluded that their success is limited to finely divided coals, which is of limited applicability to cokemaking. Studies during carbonisation have shown that the retention of sulphur in coke is rank dependent, high rank coals retaining about 70% and low rank coals about 50% of their original sulphur. Difference in loss of pyritic sulphur in high and low rank coals has been attributed to the amount of oxygen in the coal. Of the numerous additives used to promote sulphur reduction, only titanium dioxide was found to be effective, however the mechanism for this reduction was not deduced. Studies of variations in carbonisation conditions have shown that there is little scope for further sulphur reduction over that normally occurring during carbonisation. Similarly, post-carbonisation treatments with reactive gases and liquids, using conditions likely to be acceptable in metallurgical coke production, have not shown any further sulphur reductions. 69 refs., 19 figs., 23 tabs.

32069 (FRNC-TH-3553) **Contribution to the study of complex physical phenomena in gas-solid reactors for coal hydro-pyrolysis.** Saatdjian, E. Paris-6 Univ., 75 (France). Mar 1987. 94p. (In French). Order Number DE90790600. Available from NTIS (US Sales Only), PC A05/MF A01.

A reactor for entrainment of coal particles by hot hydrogen and rapid cooling is modeled. Controllable parameters: initial gas temperature, coal particle size, reactor length, flow rate of the two phases are chosen for optimum conversion. The model is compared to published experimental results. Radiative transfers in a two-phase medium gas-solid particles and gas-solid flow are calculated. Then a flow of hot argon cooled in a cylindrical tube is simulated.

32070 (FRNC-TH-3557) **Contribution to the study of a steam arc plasma. Application to pulverized coal gasification.** Meillot, E. Toulouse-3 Univ., 31 (France). Centre de Physique Atomique. 1988. 227p. (In French). Order Number DE90790598. Available from NTIS (US Sales Only), PC A11/MF A01.

A plasma reactor prototype using steam as the plasma gas is developed. Electric power is about 100 kW and thermal efficiency up to 80% for a steam flow rate of about 2.5 g/s. The cathode is protected by an argon flow. The thermodynamic properties of argon/steam mixture - chemical composition, mass enthalpy, specific heat - are computed at atmospheric pressure from 700 K to 15000 K for complete thermodynamic equilibrium. Transport coefficients (thermal conductivity, viscosity, electrical conductivity) are examined. The steam plasma thermolysis is studied: an analytical model simulates the chemical kinetics of the H_2O system. The pulverised coal gasification in plasma is presented. Sizing of the plasma reactor is examined for high temperature synthesis of the reducing gas for direct reduction of iron ore. Temperature, yield and flow rate of product gas are calculated for three different kinds of coal. A numerical model describes the pulverised coal gasification in an entrained-bed plasma reactor. The coal devolatilization is described by a two reactions model: fast at low temperature, or efficient at high temperature. The size distribution of pulverised coal particles is taken into account. The kinetics of the heterogenous reactions is governed by the gas-solid reaction rate and the diffusion rate.

32071 (ORNL/TM-11524) **Mechanical property characterization of fiber-reinforced SiC matrix composites.** Stinton, D.P.; Lowden, R.A.; Krabill, R.H. Oak Ridge National Lab., TN (USA). Apr 1990. 35p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. Order Number DE90010257. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Mechanical properties of Nicalon-fiber-reinforced silicon carbide (SiC) matrix composites fabricated by a forced chemical vapor infiltration (CVI) process have been measured and compared with properties of composites fabricated by a conventional isothermal process. Flexure strengths, tensile strengths, and fracture toughnesses measured at room temperature and flexure strengths measured at high temperatures are nearly identical for composites fabricated by the two processes provided that hot-face temperatures <1200°C are used for the forced CVI process. Reduced strengths are observed for composites fabricated by forced CVI at temperatures >1200°C because of the degradation in strength of Nicalon fibers. Composites reinforced with more stable Tyranno fibers were fabricated by forced CVI and exhibited mechanical properties similar to those of Nicalon-reinforced composites. Composites reinforced with Tyranno fibers also exhibited improved high-temperature strengths. 33 refs., 7 figs., 6 tabs.

32072 (PB–90-169020/XAB) **Development of fixed-bed-type hot-gas-cleanup technology for coal-derived gas.** Suehiro, M.; Kawamura, S.; Seto, T.; Kouno, S.; Komura, S. Mitsubishi Heavy Industries Ltd., Tokyo (Japan). c 1989. 7p. Available from NTIS, PC A06/MF A01.

Text in Japanese; Pub. in Mitsubishi Juko Giho, Vol. 26, No. 5, 397-402(1989).

Coal gasification combined cycle power plants are expected to be of practical use, in view of its prominent environmental preservation and higher thermal energy efficiency. Mitsubishi Heavy Industries, Ltd. installed a 2 t/d Hot Gas Cleanup Process Development Unit in November, 1985 and has successfully tested it under cooperation with the Central Research Institute of Electric Power Industry. The initial objective performance was accomplished in 1986. The process development unit test was carried out and got anticipated results in a comparatively short duration. Various tests, including laboratory tests and system studies, have been carried out since 1986 for the purpose of obtaining supplementary data for a pilot plant design. The report concerns the development situation of the Fixed Bed Type Hot Gas Cleanup Process.

32073 (PB–90-177049/XAB) **Dow Syngas Project Monitoring Review Committee Meeting Report. Held in Plaquemine, Louisiana on September 14, 1989.** Dow Chemical Co., Plaquemine, LA (USA). 14 Sep 1989. 85p. Available from NTIS, PC A05/MF A01.

The Energy Security Act of 1980 established a program to provide financial assistance to private industry in the construction and operation of commercial-scale synthetic fuels plants. The Dow Syngas Project design is a high-temperature entrained-flow slagging type gasifier that began operating in 1987. Dow agreed to comply with existing environmental regulations and to develop an Environmental Monitoring Plan (EMP) incorporating supplemental monitoring in areas of potential environmental and health concern, relative to synthetic fuels facilities. The phases of monitoring in the EMP will test parameters of interest in air, water and solid waste for evaluating plant operations and for establishing a data base of information for resolving environmental uncertainties relative to replication of synthetic fuels plants. The Monitoring Review committee's discussion of monitoring results from 1988 and 1989 is documented in the report.

32074 (PB–90-863655/XAB) **Coal liquefaction and hydrogenation: Processes and equipment. September 1971-November 1989 (A Bibliography from the US Patent data base). Report for September 1971-November 1989.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 105p. Available from NTISPC N01/MF N01.

This bibliography contains citations of selected patents concerning coal liquefaction and hydrogenation. Coal-liquefaction and -hydrogenation processes, catalysts and catalyst recovery, desulfurization, pretreatment of coals, energy recovery processes, solvent-product separation, and process variables are among the topics discussed. Liquefaction and hydrogenation processes include those employing catalysts such as manganese compounds, iron compounds, or chromium compounds; metal/iodine systems using different feedstocks such as coal solvent slurries, coke, extracted coals, distilled coals, or other pretreated coals; and systems using different hydrogenating gases such as methane or hydrogen. (Contains 253 citations fully indexed and including a title list.)

32075 (PB–90-863739/XAB) **Coal gasification. March 1972-January 1990 (A Bibliography from the US Patent data base). Report for March 1972-January 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 95p. Available from NTISPC N01/MF N01.

This bibliography contains citations of selected patents concerning devices and processes used in the gasification of coals. Coal-gasification processes, catalysts, and catalyst recovery; desulfurization during gasification; heating methods; pretreatment of coals; process variables; heat recovery; and peripheral equipment are cited. Examples of gasification processes include catalytic systems using alkali metals, stream decomposition, air or oxygen decomposition, thermal cracking, coal-water suspension systems, arc-discharge burning, and fluidized-bed gasification. Liquefaction of coal is examined in a related published bibliography. (Contains 214 citations fully indexed and including a title list.)

32076 **Pyrolytic behavior of a coal particle: Effect of unsteady state heating and temperation gradients.** Misra, M.K. (Ohio State Univ., Columbus, OH (USA). Dept. of Mechanical Engineering); Essenhigh, R.H. 87-99 of Proceedings of the 1987 spring technical meeting of the Combustion Institute on combustion fundamentals and applications. Combustion Institute, Pittsburgh, PA (USA) (1987). (CONF-870541–: Combustion fundamentals and applications: spring technical meeting of the Central States Section of the Combustion Institute, Argonne, IL (USA), 11-12 May 1987).

Calculations were carried out to examine the effect of unsteady state heating of coal particles, focusing particularly on the effect of temperature gradients within particles on the overall reaction rates and, on the variation of the magnitudes of these temperature gradients with particle size and heating rates. High temperature gradients predicted by calculations on inert particles supported the expected possible effect of temperature gradients on reaction rates, but, the magnitudes of the temperature gradients were reduced for a particle undergoing pyrolysis. However, the temperature differences were high enough to have significant effect on reaction rates. Calculations on captive coal particles, pyrolyzing in a thermal radiation field, showed that the temperatures were uniform in particles smaller than 500 microns, and that particles smaller than 100 microns pyrolyzed at constant temperatures. Variation in total pyrolysis time with particle size was predicted and compared with values reported in the literature.

32077 **Genetic manipolation of acidophilic bacteria.** Ward, T.E. (Idaho National Engineering Lab., Idaho Falls, ID (USA)); Rowland, M.L.; Glenn, A.W.; Watkins, C.S.; Bruhn, D.F.; Bulmer, D.; Roberto, F.F. 150-158 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). DOE Contract AC07-76ID01570. (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

Thiobacillus ferrooxidans is important in leaching of metals from mineral ores and in the removal of pyritic sulfur from coal. It is also intimately involved in production of acid mine drainage. Other acidophilic bacteria, including members of the genus Acidiphilium, are usually present in the same environments as Thiobacillus ferrooxidans. and there is evidence to suggest that these acidophilic heterotrophs may increase the rate of the attack on inorganic sulfides. The use of one or more of these acidophilic bacteria for removal of sulfur from coal may offer advantages over chemical and physical methods in the areas of capital investment, operating costs and lowered environmental pollution, since the processes take place at ambient temperature and pressure, and do not involve addition of large amounts of hazardous materials. The authors' laboratory is studying the genetic characteristics of these acidophilic bacteria and developing techniques for introducing desirable genes into them.

32078 **Co-processing and tar-sands resid: A new approach to alternative transportation fuels.** Medina, R.J. (Center for Applied Energy Research, 3572 Iron Works Pike, Lexington, KY (US)); Keogh, R.A.; Davis, B.H. 483-489 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

Each generation experiences new approaches; this applies to organizations as well as to individuals. This is certainly true for what is known as co-processing today. Co-processing which is the simultaneous reaction of coal and petroleum resid, or crude oil, with hydrogen to produce distillable liquids is the main topic of this paper. The technology may rightly be considered a variation of direct liquefaction, but its rapid development toward commercial readiness entitles it to consideration as a separate technology. It has only been within the last few years that serious consideration has been given to the process possibilities of hydrocracking petroleum resid while liquefying coal in the same reactors. In the U.S., for example, the research and development during the energy crisis of the 1970s concentrated upon converting coal; thus, the solvent used in the direct liquefaction processes of that time was derived from the coal.

32079 **A techno-economic evaluation of copressing technologies.** Gray, D. (Mitre Corp., McLean, VA (USA)); Tomlinson, G.C.; El-Sawy, A. 670-676 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

This paper provides an outline of the methodology that has been developed to allow a comparative technical and economic analysis of coal liquefaction using the HRI CTSL process, coprocessing using the HRI technology, and resid upgrading using the H-OIL process. These three similar technologies have been evaluated on as comparable a basis as possible so that their relative technical and economic merits can be identified. The approach used to perform this analysis also allows sensitivity analyses to be performed with respect to feedstock costs and other significant parameters so that the conditions for economic utilization of coprocessing can be identified.

32080 **Mild gasification liquid characterization data for sytems modeling and assesment.** Klara, J.M. (USDOE Morgantown Energy Technology Center, WV (USA)). 757-764 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

The goal of this effort was to obtain detailed chemical and physical data for a representative mild gasification liquid in order to better evaluate possible markets as well as to more accurately simulate the mild gasification process in system analyses. The data obtained from the characterization study revealed that his mild gasification liquid was aromatic in nature. The liquid was of relatively high quality, with comparable sulfur content as some crude oils and less nitrogen than shale oil. Furthermore, the liquid contained almost no particulate matter, exhibited a viscosity similar to that of a fuel oil, and produced refinery stock yields similar to those of a high quality crude oil. Potential markets include those for chemical feedstock and high energy density fuels. Saturation of the aromatic compounds is most likely required in order to meet the specifications for conventional transportation fuels. Determination of the possible upgrading steps required to meet end-use specifications could be facilitated by the acquisition of these characterization data. The author concludes that to effectively evaluate the potential of mild gasification processes, detailed liquid characterization data obtained by standard techniques are essential.

0105 Products and By-Products

Refer also to citation(s) 32058, 32060, 32061, 32062, 32063, 32064, 32065, 32117

32081 **Behavior of phenol and aniline on selected sorbents and energy-related solid wastes.** Bishop, D.J. (Lawrence Livermore National Laboratory, Livermore, CA (USA). Environmental Sciences Division); Knezovich, J.P.; Harrison, F.L. *Water, Air and Soil Pollution (Netherlands)*, 49(1/2): 92-106 (Jan 1990).

The sorption and desorption of phenol and aniline on selected soils and soil components and on some energy-related solid wastes were investigated. Isotherms were generally nonlinear and were described usually by the Freundlich equation. Most partition coefficients were low, and no significant correlation was shown with organic C content, pH, cation exchange capacity, or particle-size of the sorbent. it appears that sorption of small polar aromatic compounds, such as phenol and aniline, cannot be defined by a single sorbent characteristic, but is affected by both the organic and mineral components of the sorbents. Hysteresis was observed in most sorption-desorption experiments; a fraction of the sorbate was irreversibly held by the sorbent. 28 refs., 3 tabs., 3 figs.

0106 Properties and Composition

Refer also to citation(s) 32041, 32042, 32107, 32108, 32118, 32780

32082 (BEG-RI–188) **Organic petrography, and organic geochemistry of Texas Tertiary coals in relation to depositional environment and hydrocarbon generation.** Mukhopadhyay, P.K. Texas Univ., Austin, TX (USA). Bureau of Economic Geology. 1989. 118p. Available from The University of Texas at Austin, BEG, Publication Sales, University Station, Box X, Austin, TX 78713, USA.

Comprehensive organic petrological, organic geochemical, and chemical analyses were conducted on 156 samples of Tertiary coals from the Wilcox, Claiborne, and Jackson Groups in northeast, east-central, East, and South Texas. Samples were collected from outcrop, near-surface mines, and boreholes and classified into three maceral types (humic, mixed, and sapropelic) on the basis of hydrocarbon potential and maceral composition. The author used ternary diagrams of maceral-composition relations between ratios of macerals of similar affinity, selected palynological data, and physicochemical properties to distinguish specific peat-forming paleoenvironments within the Tertiary strata. These data establish the variability of depositional environments, depositional relations between maceral groups, and chemical properties of the Texas coals. Procedures used to evaluate hydrocarbon chemistry include Rock-Eval pyrolysis, gas chromatography, and hydrous and anhydrous pyrolysis. 36 figs., 14 tabs.

32083 (DOE/PC/88934–T5) **Enhancement of surface properties for coal beneficiation: Technical progress report, January 1, 1990–March 31, 1990.** Chander, S.; Aplan, F.F. Pennsylvania State Univ., University Park, PA (USA). [1990]. 9p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88934. Order Number DE90011081. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The main objective of this research project is to study ways to modify surface properties of coal, pyrite and ash-forming mineral matter for beneficiation of fine coal. Since the differences in surface properties of coal and mineral matter are utilized in several oil based preparation technologies, such as: froth flotation, emulsion flotation, spherical agglomeration and liquid-liquid separation, another objective is to delineate the role of oil. The following studies are being carried out to achieve the objectives stated in the previous paragraph: investigation of the natural hydrophobicity of coal and pyrite; development and evaluation of enhanced coal hydrophobicity; development and evaluation of reagents which modulate the hydrophobicity of pyrite; and development and evaluation of emulsion processes and their underlying principles. 4 tabs.

32084 (DOE/PC/89904–T2, pp. 85-88) **Studies of the energetics of C-S bond-breaking reactions in radical ions derived from coal model compounds.** Bausch, M.J. Southern Illinois Univ., Carbondale, IL (USA). Coal Extraction and Utilization Research Center. Apr 1989. In *High-sulfur coal research at the SIUC Coal Technology Laboratory. Quarterly progress report, January 1-March 31, 1989.* Order Number DE89013667. Available from NTIS, PC A06/MF A01.

Contained in this project update is new fact concerning the strength of the benzylic C-S bond in the radical anion derived from benzyl methyl sulfide. Using gas phase and electrochemical data, the author has calculated a C-S bond dissociation energy in 1 of ~ 22 kcal/mol. This is the first estimate of a C-S bond energy in a radical anionic coal model compound. The relatively large negative value for this bond strength points to the feasibility of an organic sulfur removal protocol that is based on the initial chemical reduction of raw coal.

32085 **New analytical methods for organic sulfur in coal.** Markuszewski, R. (Iowa State Univ., Ames (USA)). 21 of Division of Geochemistry, Inc. 197th ACS National Meeting. American Chemical Society, Washington, DC (US) (1989). (CONF-8904133–: Symposium on geochemistry of sulfur in fossil fuels, Dallas, TX (USA), 9-14 Apr 1989).

The nature of organic sulfur in coal will be briefly discussed, and analytical methods, those currently available as well as those under development, for the direct and indirect determination of organic sulfur in coal will be surveyed. Indirect (ASTM) procedures as well as direct methods based on selective reduction will be summarized. Among promising new methods are those that rely on step-wise oxidation of the various sulfur forms and subsequent measurement of the sulfur dioxide or sulfate released. Also, instrumental techniques such as electron microprobe with energy-dispersive x-ray analysis are very useful, especially in confirming desulfurization results from

chemical processing of coal. For the sake of completeness, other less acceptable methods will also be included in the discussion.

32086 Local structure evaluation in solid amorphous mixtures by double cross polarization C13 nuclear magnetic resonance spectrometry. Hagaman, E.W. (Oak Ridge National Lab., TN (USA)); Woody, M.C. 27 of Division of Geochemistry, Inc. 197th ACS National Meeting. American Chemical Society, Washington, DC (US) (1989). DOE Contract AC05-84OR21400. (CONF-8904137--: Symposium on advances in NMR spectroscopy of humic substances and coals, Dallas, TX (USA), 9-14 Apr 1989).

The ^{1}H-^{13}C-^{31}P double cross polarization (DCP)/MAS ^{13}C-NMR experiment has been used recently to characterize coals and other solid organic mixtures by providing statistical structure descriptions of chemically defined reaction centers. In cases where derivatization can be shown to be complete, e.g., esterification of phenolic residues with dimethylphosphinic chloride, the DCP experiment provides a statistical description of that particular functional group environment. The DCP spectra of aryl dimethylphosphinates contain resonances from coal centers two and three bond distances removed from the ^{31}P atom, i.e., the ipso and ortho carbons of the phenolic species. This presentation will discuss the new statistical structure information obtained from ^{1}H-^{13}C-^{31}P DCP/MAS spectra of phosphinate ester derivatives of amorphous organic mixtures.

32087 Variable temperature high speed spinning CP/MAS NMR studies of coals. Linehan, J.C. (Pacific Northwest labs., Richland, WA (USA)); Franz, J.A. 28 of Division of Geochemistry, Inc. 197th ACS National Meeting. American Chemical Society, Washington, DC (US) (1989). DOE Contract AC06-76RL01830. (CONF-8904137--: Symposium on advances in NMR spectroscopy of humic substances and coals, Dallas, TX (USA), 9-14 Apr 1989).

Quantitative aspects of the application of ultra high speed spinning ^{13}C CP/MAS NMR spectroscopy at 75 MHz will be discussed for a variety of coals spanning lignite to low volatile bituminous along with biodegraded and oxidized coals. Cross polarization dynamics and relaxation properties of coals are being examined at low temperatures and as a function of moisture content. Enhancement of structural features and increased detection sensitivity observed at low temperatures is discussed in terms of effects of water and motion dynamics on the polarization transfer process of mobile functional groups in the coal.

32088 Supercritical extraction-time-of-flight mass spectrometry with electron impact ionization of coal and coal model compounds. Neill, P.H. (Argonne National Lab., IL (USA)); Graczyk, L.J.; Winans, R.E. 1-1 of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-890331--: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 261.

The objective of the technique described here is to obtain electron impact (EI) mass spectra of the supercritical extracts without allowing the very reactive products to be exposed to light or oxygen. Most of the supercritical mass spectrometry interfaces reported thus far use chemical ionization. The spectra obtained from chemical ionization contain considerably less information that can be used for identification than electron impact spectra.

32089 Assessment of coal cleanability for various beneficiation processes by SEM-based automated image analysis. Straszheim, W.E. (Iowa State University, Ames, IA (USA). Ames Laboratory and Iowa State Mining and Mineral Resources Research Inst.); Markuszewski, R. *Fuel Processing Technology (Netherlands)*, 24(Spec. Issue): 445-451 (Jan 1990). (CONF-890515--: 2. international Rolduc symposium on coal science, Rolduc (Netherlands), 22-24 May 1989).

Techniques employing scanning electron microscopy-based automated image analysis (SEM-AIA) are emerging as useful tools for the characterization of coal and its associated mineral matter to be used in conjunction with advanced coal conversion and coal cleaning processes. New methodology and applications have been developed at the Ames Laboratory and Iowa State University to study the nature and amount of mineral phases, their particle size distributions, and their degree of association with the organic coal matrix. Since the mineral content and composition can vary widely from coal to coal, the detailed characterization provided by these SEM-AIA techniques is quite helpful for the planning, design, testing, and evaluation of coal beneficiation and conversion processes. The methodology of SEM-AIA is described along with several illustrative applications related to coal beneficiation. 9 refs., 3 figs., 1 tab.

0108 Waste Management

Refer also to citation(s) 32041, 32068, 32081, 32115, 32310, 32311, 32312, 32314

32090 (DOE/MC/10637--2827-Task-2.2) **Waste Management: Final technical report, April 1, 1987--March 31, 1988 including Quarterly technical progress report, January--March 1988.** North Dakota Univ., Grand Forks, ND (USA). Energy and Mineral Research Center. Apr 1988. 70p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-86MC10637. Order Number DE90011403. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Research is being conducted to characterize waste materials from advanced coal utilization processes and to develop innovative management practices for coal utilization waste disposal. The purpose is to predict the environmental impacts of wastes from several processes being developed at the University of North Dakota Energy and Mineral Research Center (UNDEMRC). The project is currently evaluating the chemical, physical, and leachate production properties of wastes from an atmospheric fluidized bed combustion (AFBC) process, a low-temperature coal gasification process, and a hot-water-drying coal slurry preparation process. Methods are also being developed for constructing fly ash liners at waste disposal sites, evaluating the use of new leaching tests for coal utilization wastes, and developing statistical procedures for analyzing soils data collected at candidate waste disposal sites. Eleven different waste materials were characterized during this reporting period. Six wastes were characterized from AFBC tests which used a coal slurry fuel. Four wastes were characterized from low-temperature coal gasification runs performed for the Hydrogen Production Project, and one waste was characterized from a coal preparation operation associated with the hot-water-drying coal slurry process. 10 refs., 18 figs., 20 tabs.

32091 (DOE/PC/89904--T2, pp. 105-108) **Corona enhanced absorption of SO_2/NO_x.** Dhali, S.K. Southern Illinois Univ., Carbondale, IL (USA). Coal Extraction and Utilization Research Center. Apr 1989. In *High-sulfur coal research at the SIUC Coal Technology Laboratory. Quarterly progress report, January 1-March 31, 1989.* Order Number DE89013667. Available from NTIS, PC A06/MF A01.

Experiments are being done to study the removal of SO_2 from flue gas using the dielectric-barrier discharge. The dielectric-barrier discharge has been found to be the most stable high-pressure (near atmosphere) discharge. Results are shown for different mass flow, discharge pressure, and SO_2 concentration. The results are extremely encouraging, and all indications are that using the dielectric-barrier discharge may be the best electrical (plasma) method for the removal of SO_2.

32092 (DOE/SR/18047--2) **Investigation on the utilization of coal fly ash as amendment to compost for vegetation in acid soil: Progress report, March 16, 1989--April 15, 1990.** Menon, M.P. Savannah State Coll., GA (USA). Dept. of Chemistry. 16 Apr 1990. 24p. Sponsored by U.S. DOE Defense Programs. DOE Contract FG09-88SR18047. Order Number DE90011088. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The use of fly ash as amendment to compost is presented. Plant growth/yields of corn collard greens, mustard greens, and sorgum is described. The treatment parameters such as fly ash to compost ratio, fly ash-amended compost to soil ratio, type of compost used for treatment etc. are discussed. 2 refs., 5 figs., 8 tabs. (CBS)

32093 (EPRI-GS--6281, pp. 6.1-6.17) **The removal and control of trace elements in coal and coal wastes.** Norton, G.A. (Iowa State Univ., Ames (USA)); Buttermore, W.H.; Markuszewski,

R.; Akers, D.J. Electric Power Research Inst., Palo Alto, CA (USA); Writing Consultants Associated, Pittsburgh, PA (USA). Oct 1989. (CONF-8710500–: Seminar on reducing power plant emissions by controlling coal quality, Bethesda, MD (USA), 27-28 Oct 1987). In *Proceedings: Reducing power plant emissions by controlling coal quality*. Order Number DE90001365. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This paper provides a review of the available literature relating to the occurrence and fate of trace and minor elements in coal, coal preparation wastes, and coal combustion wastes, as well as the impact of these trace elements on disposal and utilization technologies. In this overview, modes of occurrence and common associations of these elements in coal, fly ash, bottom ash, and scrubber sludge are discussed, and the effect of physical cleaning on the fate of trace elements is described. In addition, the probable impact on disposal and utilization technologies resulting from the removal of specific trace elements by physical processes before combustion is addressed for both coal preparation and combustion wastes. Finally, the effects of trace elements on some potential uses of coal ash and coal preparation wastes are summarized.

32094 (EUR–11448-EN) **The certification of the surface density (kg/m_2) of BCR CRM 038 ('fly ash from pulverised coal') comprised in methyl cellulose films simulating dust charged filters. BCR 128.** Griepink, B.; Marchandise, H.; Colinet, E.; Dams, R. Commission of the European Communities, Luxembourg (Luxembourg). 1988. 24p. Available from Commission of the European Communities, Luxembourg.

BCR CRM 38 ('Fly Ash') has been embedded in a stable methylcellulose foil of about 10μm thickness. This has been done by making a slurry of fly ash and methylcellulose in water and spiking it with ^{42}K as a radioactive tracer. The slurry was spread over glass plates and allowed to dry. 'Filters' of uniform size were punched out of the foil. The surface density (e.g. $\mu g/cm^2$) of the fly ash was calculated for each individual 'filter' by comparing the ^{42}K-activity of the filter with that of the initial suspension. The uncertainties in the so obtained surface density of random and of systematic origin have been estimated. The total relative uncertainty in the surface density of every element certified in BCR 38 is 4-6%. Studies of stability and homogeneity have revealed that this material is well suited for the verification of the results of non-destructive analytical techniques for dust components.

32095 **Flue gas conditioning applied to fabric filtration.** Miller, S.J. (North Dakota Univ., Grand Forks, ND (USA). Energy and Minerals Research Center); Laudel, D.L. 330-339 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

The use of conditioning agents to enhance particle collection in fabric filters is a new technology that has not been widely employed, but has significant potential. During the past four years, research has been conducted to investigate methods of enhancing fine particle capture in fabric filters. Previous results showed that some coals produce fly ash which is ore difficult to collect in fabric filters than other ashes. This led to speculation that fly ash characteristics could be modified by conditioning agents to enhance particle collection. Results of earlier experiments showed that fine particle emissions and baghouse pressure drop are reduced when small amounts of ammonia and sulfur trioxide (SO_3) are injected into the flue gas upstream of a baghouse. The conditioning agents increase the cohesive strength of the fly ash and facilitate the formation of a more porous dust cake. Previous work was conducted with shaker-cleaned and pulse-jet-cleaned bags. Further experimentation has been conducted to investigate the use of ammonia and SO_3 as conditioning agents with a reverse-air-cleaned fabric filter. The purpose of these tests was to determine whether the increase in cohesive strength of the fly ash might lead to bag cleaning problems with more gentle bag cleaning. Since reverse-air-cleaned bags are known to develop high residual dust cake weights, there was concern that conditioning might aggravate the problem. On the other hand, there was the possibility that conditioning might reduce pressure drop with reverse-air cleaning by the formation of a more porous dust cake and by facilitating dust cake release. This paper presents results of 8-hour and 500-hour tests with a pilot combustor and baghouse in which ammonia and SO_3 were injected upstream of a reverse-air-cleaned baghouse.

0109 Environmental Aspects

Refer also to citation(s) 32073, 32090, 32095, 32109, 32110, 32111, 32470, 32513, 33113

32096 (CHEC–9002) **Nitrous oxide emissions from Danish power plants.** Hulgaard, T. Danmarks Tekniske Hoejskole, Lyngby (Denmark). Inst. for Kemiteknik. Feb 1990. 38p. Available from Institut for Kemiteknik, Danmarks Tekniske Hoejskole, Bygning 229, 2800 Lyngby, Denmark.

This work focused on obtaining reliable N_2O emission data from a variety of fossil fuel fired power plants in Denmark. This included three large pulverized coal (PC) combustion plants burning bituminous coal, one equipped with low-NO_x burners and a wet limestone flue gas desulfurisation plant, and one equipped with a limestone spray absorption process. All emissions were at or below 3 ppm referring to volume (ppmv), whereas a small PC plant (5 MWe) gave up to 5 ppmv. A natural gas fired turbine (15 MWe) and a laboratory scale fiber burner showed below 2 ppmv. Few ppmv were found from straw combustion in a 5 MWe 'cigar burner' boiler. Pilot plant experiments using ammonia or urea as reductants in the selective non-catalytic reduction of NO show a small production of N_2O using ammonia, but significant production using urea. The use of certain additives together with NH_3 also causes N_2O production. N_2O emissions in the range 25-200 ppmv were obtained in a 2 MWt coal fired circulating fluidized bed, depending on, for instance, the temperature and excess oxygen level. Low temperature and high excess O_2 apparently cause high emissions. However, other parameters, which are not well known at present, must be important as well. Analysis of N_2O was performed by grab sampling in Tedlar bags followed by gas chromatographic analysis (GC) or by on-line infrared analysis (IR). The GC method is most accurate if the necessary precautions to avoid N_2O formation in the sample are taken. IR analysis is continuous and faster than GC, but suffers from interference from especially SO_2, H_2O, and CH_4.

32097 (CONF-9004110–2) **The Argonne Utility Simulation model: An analysis tool for evaluating energy and environmental strategies.** Veselka, T.D.; Novickas, A.; Love, R. Argonne National Lab., IL (USA). [1990]. 7p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. From 4. national conference on microcomputer applications in energy; Tucson, AZ (USA); 25-27 Apr 1990. Order Number DE90011091. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Argonne Utility Simulation (ARGUS) model accounts for the interplay of economic, environmental, and technological factors in energy policy issues and emission-control strategies. Each of the four major components of ARGUS represents a species aspect of the utility sector. One component deals with meeting future electricity demand through construction of new units or refurbishment or repowering of existing units. A second component is concerned with the probability of generating-unit failure and the effect that such failure could have on generating-unit assignment, fuel use, and cost. A third component computes the cost of the implementing emission-control regulations and strategies. The fourth component forecasts delivered coal prices based on the volume of coal, supply region, and transportation route. 16 refs., 3 figs.

32098 (CRIEPI-T–88086) **Anthropogenic sulfur dioxide emission in Far East Asia.** Fujita, S. (and others). Central Research Inst. of Electric Power Industry, Tokyo (Japan). 1989. vp. (In Japanese). Available from Central Research Institute of Electric Power Industry, Tokyo (Japan).

A preliminary sulfur dioxide emission inventory for East Asia, including Japan, China, Taiwan and South and North Korea was developed. The annual emission rate of fossil-fuel related sulfur was estimated for a 80 km mesh grid by use of energy consumption and industrial activities of the region as basic indicators. The estimated total sulfur dioxide emissions in this area amounted to about nineteen million tons per year. This value is almost equal to that in Northwestern Europe or Northeastern United States where

acid deposition occurs. About ninety percent of total emisisons is from China, particularly the area surrounding the Bo-Hai Bay (Hebei, Shandong and Liaoning Provinces). Emissions from mobile sources are relatively small, and coal-fired stationary sources contribute a large part of the sulfur dioxide emissions in East Asia.

32099 (PB–90-163718/XAB) **Determination of drainage density for surface-mine reclamation in the western US. Final report.** Gregory, D.I.; Schumm, S.A.; Watson, C.C. Office of Surface Mining Reclamation and Enforcement, Denver, CO (USA). Jul 1985. 66p. Available from NTIS, PC A04/MF A01.

As part of any surface-mined land reclamation plan, quantitative geomorphic data is required in order that relatively stable landforms can be constructed. Drainage density is an extremely important characteristic of the landscape that reflects the interaction between eroding forces and the erodibility of an area. There is a characteristic drainage density for each location, and when this is identified, it should be used in reclamation design. Mining and reclamation will change other properties of drainage basins, which will, in turn, affect drainage density. Baselevel control provided by resistant bedrock outcrops may be removed; infiltration capacity may be decreased by mixing fine-textured subsoil with topsoil; and relief may be increased through bulking of overburden or decreased by removal of thick coal seams. Therefore, the characteristic drainage densities will require adjustment as a result of these changes, and additional research is needed in order to refine estimates of drainage density.

32100 (PB–90-163767/XAB) **Comparison of hydrologic data from mined and unmined areas in the carbondale Group of Daviess, Pike, and Gibson Counties, Indana. Final report.** Indiana Univ. Foundation, Bloomington, IN (USA). 6 Nov 1989. 143p. Available from NTIS, PC A07/MF A01.

The study ascertained the baseline hydrologic conditions in Indiana's major coal reserve sequence of rocks, the Pennsylvania Carbondale Group, and the effects of coal mining on the ground water regime. Numerous small acquifers and aquitards and long uncased well intervals made sampling difficult for individual acquifers. Water chemistries vary considerably making generalizations difficult. Water quality standards were exceeded in 85% of wells in both mined and unmined areas for TDS.

32101 (PB–90-167693/XAB) **Surface-water hydrology and sedimentology manual. Final report.** Eggert, K.G.; Li, R.M.; Liang, W.S.; Peterson, M.R.; Schall, J.D. Sato (J.F.) and Associates, Inc., Littleton, CO (USA). 6 Nov 1989. 686p. Available from NTIS, PC A99/MF A04.

See also PB–90-167701.

The document is a presentation of techniques thought to be most appropriate for analysis of mineland hydrology, hydraulics, geomorphology sedimentation and associated hydraulic structures in the western United States. The volume serves as a reference for the evaluation and review of mine plans, and to provide background for the material included in the accompanying volume Hydrology and Sediment Yield Work Manual. However, it is also addressed to the larger problem of acquiring an understanding of the physical processes associated with runoff acting in a surface mining environment.

32102 (PB–90-167727/XAB) **Soil survey versus crop production as a measure of soil productivity: Soil characteristics as predictors of corn and soybean yields, NCSS (National Cooperative Soil Survey) data base. Final report.** Jansen, I.J.; Vance, S.L.; Walker, W.M. Illinois Univ., Urbana, IL (USA). Dept. of Agronomy. 30 Dec 1985. 78p. Available from NTIS, PC A05/MF A01.

See also PB–90-167735.

Information has been assembled concerning land as a resource for farming and other endeavors. Major land resources areas (MLRAs) consist of geographically associated land resource units characterized by particular patterns of soil, climate, use and type of farming. The National Cooperative Soil Survey data base contains information concerned with crop yield and soil characteristics associated with MLRAs. Within MLRAs are various soils that have different chemical and physical properties such as soil pH, percent organic matter and texture, and that have different characteristics such as erosion and slope. A major objective of the project was to establish and evaluate a general, quantitative relationship between soil characteristics and yields for MLRAs in Iowa and Illinois. Statistical model building procedures were the methodology used in the evaluation and the test crops were corn and soybeans since these crops are widely produced in both states and on most soils.

32103 (PB–90-167735/XAB) **Soil survey versus crop production as a measure of soil productivity: Soil-strength effects on row-crop yields. Final report.** Jansen, I.J.; Vance, S.L.; Walker, W.M. Illinois Univ., Urbana, IL (USA). Dept. of Agronomy. 30 Dec 1985. 24p. Available from NTIS, PC A03/MF A01.

See also PB–90-167727.

The objective of the study was to examine the use of a recording cone penetrometer as a predictor of crop yield for constructed soils. State-of-the-art reclaimed land in Illinois is capable of producing good corn and soybean yields. Previous research has examined observable features of constructed soils ranging from those which are highly drought sensitive to those which are highly productive for causes of the observed crop performance differences. The studies have made it increasingly evident that poor soil physical condition is the major factor limiting row crop productivity following surface mining in Illinois. Efforts to build significant yield prediction models based on penetrometer data were successful. Too much yield variation remained unaccounted for to use these models alone to predict productivity of reclaimed land for reclamation law enforcement.

32104 (PB–90-185000/XAB) **Identification of hydro data sources for use in mine plan review assessment of cumulative hydrologic impacts of surface mines Final report.** Humphreys, C.P. Geological Survey, Harrisburg, PA (USA). Water Resources Div. Mar 1983. 264p. Available from NTIS, PC A12/MF A02.

Portions of this document are not fully legible.

The report presents tables of total numbers of hydrologic data sites for each coal and adjacent county in the primacy states by source and type of data. The information consists of surface-water, quality-of-water, sediment, and ground-water data sites.

32105 (SNM-BAC–89/1) **Nature demands stricter limits.** Smit, H. (ed.). Stichting Natuur en Milieu, Utrecht (Netherlands). 1989. 64p. (CONF-8904353–: NGO strategy seminar on air pollution, Ede (Netherlands), 3-4 Apr 1989). Available from Milieuboek, Henri Polaklaan 42, NL-1018 CT Amsterdam, the Netherlands.

The 7 lectures given are entitled: critical loads of sulphur and nitrogen on forests, groundwater and surface water; effects of air pollution on plants: critical levels; the UN ECE convention - implications for the NGOs; NGO strategy on acidification: the European situation; NGO strategies; financing air pollution abatement: a levy-fund system; and strategies for improving east-west cooperation in the field of environmental protection. Reports from the working groups on energy, transport and agriculture, and a list of participants are included.

0110 Reserves, Geology, and Exploration

32106 (PB–90-183229/XAB) **Geologic evaluation of critical production parameters for coalbed methane resources. Part 1. San Juan Basin. Annual report, August 1988-July 1989.** Ayers, W.B.; Kaiser, W.R.; Ambrose, W.A.; Swartz, T.E.; Laubach, S.E. Texas Univ., Austin, TX (USA). Bureau of Economic Geology. Jan 1990. 180p. Available from NTIS, PC A09/MF A01.

See also PB–89-142574.

In the San Juan Basin, Fruitland Formation coal seams contain an estimated 43 to 49 Tcf of methane. With more than 500 producing coalbed methane wells and approximately 1,000 wells scheduled for drilling in 1990, the basin is one of the most active areas of coalbed methane exploration and production in the United States. Among the most important geologic factors affecting the occurrence and producibility of coalbed methane are depositional setting, structural attitude and fracturing of the coal, and regional hydraulic setting. In the second year of the study, the Bureau of Economic Geology evaluated the depositional setting and structure of Fruitland coal seams, which are both source rocks and reservoirs for coalbed methane, throughout the basin. The report

summarizes the regional tectonic setting of the San Juan Basin; describes the Cretaceous stratigraphy, structure, and basin evolution; relates these factors to Fruitland coal and coalbed methane occurrence; describes studies of lineaments, fractures, and cleats; presents hydrodynamic controls on the producibility of coalbed methane from the Fruitland Formation; summarizes production from the Fruitland Formation; and evaluates geologic and hydrologic controls on coalbed methane producibility.

32107 **On the nature of organosulfur constituents in Rasa lignite.** White, C.M. (Pittsburgh Energy Technology Center, PA (USA)); Douglas, L.J.; Anderson, R.R.; Schmidt, C.E. 4 of Division of Geochemistry, Inc. 197th ACS National Meeting. American Chemical Society, Washington, DC (US) (1989). (CONF-8904133–: Symposium on geochemistry of sulfur in fossil fuels, Dallas, TX (USA), 9-14 Apr 1989).

Rasa lignite contains extraordinarily high levels of sulfur, around 12%, most of which is organic sulfur. It presents a unique opportunity to study organosulfur constituents in lignite that are present in high concentrations which are not obscured by a large nonsulfur-containing matrix. Rasa lignite was extracted with pyridine for five days and, the extract was analyzed by low-voltage high-resolution mass spectrometry (LVHRMS). The molecular formulae of many organosulfur compounds (not previously reported in coal) were observed. Some compounds contained two or three sulfurs. This information on the nature of organosulfur constituents in Rasa lignite provides a basis for speculation on the structure of individual organosulfur constituents in the lignite.

32108 **Sulfur compounds in coals containing multiple heteroatoms.** Winans, R.E. (Argonne National lab., IL (USA)); Melnicoff, P.E.; Neill, P.H. 3 of Division of Geochemistry, Inc. 197th ACS National Meeting. American Chemical Society, Washington, DC (US) (1989). DOE Contract W-31-109-ENG-38. (CONF-8904133–: Symposium on geochemistry of sulfur in fossil fuels, Dallas, TX (USA), 9-14 Apr 1989).

Flash vacuum pyrolysis of a high sulfur coal has been combined with high resolution mass spectrometry yielding information on aromatic sulfur compounds containing an additional heteroatom. Sulfur emission from coal utilization is a critical problem and in order to devise efficient methods for removing organic sulfur, it is important to know what types of molecules containing sulfur. A high sulfur Illinois No. 6 bituminous coal (Argonne Premium Coal Sample #3) was pyrolyzed on a platinum grid using a quartz probe inserted into a modified all glass heated inlet system. An MS-50, operating with an EI source at low eV and 70 eV with resolving powers up to 80,000, was used to characterize the products. The high resolving power over a broad mass range of 100-650 was necessary to separate the aromatic sulfur compounds from certain hydrocarbons. A series of alkylated compounds derived from phenoxathiin and phenothiazine were identified. These compounds were differentiated from other isomers by chemical modification of the coal and also by off-line LC separations. These compounds were found in significant amounts for the first time in coal.

0120 Mining

32109 (GAO/RCED–89-140FS) **Surface mining: information of legal fees under the surface mining act.** General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div. Jun 1989. 18p. Available from US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877 (USA).

This paper reports on a GAO study of attorney and expert witness fees awarded as a result of litigation brought under the Surface Mining Control and Reclamation Act. As of March 24, 1989, a total of about $1.4 million had been awarded in attorney fees and expenses - about $1.3 subject to the provisions of the Employee Retirement Income Security Act, a comparison of its features with provisions of ERISA showed that the plan differed from ERISA provisions in areas such as eligibility, funding, and contribution limits.

32110 (PB–90-179474/XAB) **Improved emission factors for fugitive dust from Western surface-coal-mining sources. Volume 1. Sampling methodology and test results.** Axetell, K.; Cowherd, C.; Herrmann, J.G.; Pace, T.G. PEDCo-Environmental, Inc., Kansas City, MO (USA). Jul 1981. 217p. Available from NTIS, PC A10/MF A02.

See also Volume 2, PB–90-179482.

The primary purpose of the study was to develop emission factors for significant surface coal mining operations that are applicable at all mines and are based on widely acceptable, state-of-the-art sampling and data analysis procedures. Primary objectives were (1) to develop emission factors for individual mining operations, in the form of equations with several correction factors to account for site-specific conditions; and (2) to develop these factors for particles less than 2.5 micrometers (fine particulates), particles less than 15 micrometers (inhalable particulates), and total suspended particulates. Secondary objectives were (1) to determine deposition rates over the 50- to 100-m distance downwind from the source, and (2) to estimate control efficiencies for certain source categories. Emissions resulting from the following were sampled at three mines during 1979 and 1980: drilling, blasting, coal loading, bulldozing, dragline operations, haul trucks, light- and medium-duty trucks, scrapers, graders, and wind erosion of exposed areas. The primary sampling method was exposure profiling, supplemented by upwind/downwind, balloon, wind tunnel, and quasi-stack sampling. The number of tests run totaled 265. The report concludes with a comparison of the generated emission factors with previous ones, a statement regarding their applicability to mining operations, and recommendations for additional research.

32111 (PB–90-179482/XAB) **Improved emission factors for fugitive dust from Western surface coal mining sources. Volume 2. Emission factors.** Axetell, K.; Cowherd, C.; Herrmann, J.G.; Pace, T.G. PEDCo-Environmental, Inc., Kansas City, MO (USA). Nov 1981. 82p. Available from NTIS, PC A05/MF A01.

See also Volume 1, PB–90-179474.

The project involved the development of emission factors for operations at surface coal mines located in the western United States. Operations sampled included, but were not limited to, haul road traffic, scrapers, draglines, and blasts. Sampling techniques used included exposure profiling, upwind-downwind and wind tunnel testing. From the information, emission factors were developed which take into account such characteristics as soil moisture and silt content. The data presented in the study should aid both private industry and government agencies in evaluating emissions from coal mining operations.

0130 Transport, Handling, and Storage

Refer also to citation(s) 32089

0140 Combustion

Refer also to citation(s) 32041, 32190, 32513, 32543

32112 (CONF-900546–2) **Development of nondestructive evaluation methods and prediction of effects of flaws on the fracture behavior of structural ceramics.** Ellingson, W.A. (Argonne National Lab., IL (USA)); Singh, J.P.; Gopalsami, N.; Dieckman, S.L.; Chu, C.-Y.; Hentea, T.; Rizo, P. Argonne National Lab., IL (USA). Apr 1990. 14p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. From 4. conference on fossil energy materials; Oak Ridge, TN (USA); 15-17 May 1990. Order Number DE90011092. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

To establish predictive performance (i.e., fracture behavior) of structural ceramic composites, we undertook in combination (1) a study of flaws and material variations as they relate to mechanical properties and (2) development of non-destructive devaluation (NDE) methods suitable for obtaining data on flaws and material variations. Effects of whisker addition on development of flaw population and the resulting mechanical properties were evaluated for both green (cold-pressed) and dense (hot-pressed) Si_3N_4-whisker-reinforced Si_3N_4 matrix composites. To detect critical flaws in these composites, microfocus x-ray computed tomography and ultrasonic NDE methods were used. In addition, a nuclear magnetic resonance (NMR) facility was designed for use on composites. 14 refs., 6 figs, 3 tabs.

32113 (DOE/FE–0183P) **Heat engines program: Fiscal year 1990, Summary program plan.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of the Deputy Assistant Secretary for Coal Technology. Sep 1989. 38p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90010276. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Office of Coal Technology (OCT) in FE is concentrating its efforts on two internal combustion engines — the open cycle gas turbine and the diesel engine — that utilize gas- and oil-based fuels today but have the potential for burning coal in the future. Research in these areas is briefly described, along with a discussion on program strategy. 5 figs.

32114 (DOE/PC/88913–T5) **Mechanics/heat-transfer relation for particulate materials: Quarterly report.** Campbell, C.S. University of Southern California, Los Angeles, CA (USA). Dept. of Mechanical Engineering. Apr 1990. 6p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88913. Order Number DE90011143. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This quarter we have been trying to extend our work on particle pressure measurements in gas-fluidized to smaller particles and, eventually down into the particulate fluidization regime. These results show a large increase of activity around the minimum fluidization point which may be expected as the smaller particles are more susceptible to interstitial fluid forces. We have also begun work with the dry particle Couette shear cell and the preliminary results indicate that the conductivity varies with the shear rate, exactly as the apparent viscosity. 5 figs.

32115 (DOE/PC/89904–T2, pp. 101-104) **Beneficiated fine-particle coal as a source of energy in small-scale applications.** Rajan, S. Southern Illinois Univ., Carbondale, IL (USA). Coal Extraction and Utilization Research Center. Apr 1989. In *High-sulfur coal research at the SIUC Coal Technology Laboratory. Quarterly progress report, January 1-March 31, 1989.* Order Number DE89013667. Available from NTIS, PC A06/MF A01.

The fundamental processes occurring during the pulsating combustion of coal are at the present not clearly understood. Earlier experimental investigators have shown that combustor frequency, heat release rate, temperature profiles, fuel-air stoichiometry, etc. all influence the efficiency and NO_x and SO_2 formation during coal combustion in the pulsating mode. In an effort to probe further and understand how the above factors control the basic mechanisms of heat release and SO_2 and NO_x formation, a theoretical modeling study has been initiated this quarter. Details of the literature study directed towards this goal are given in this report.

32116 (EUR–11794-EN) **Industrial burners for combustion of high concentration water-coal slurries and respective combustion.** Snamprogetti SpA, San Donato Milanese (Italy). 1988. 78p. Available from Commission of the European Communities, Luxembourg.

The project was aimed at identifying the elements that were still missing in order to achieve a degree of technical reliability of coal water mixture (CWM) combustion technology similar to that of conventional fuels. Experimentation on an industrial scale was required to achieve the combustion technology development objectives. This experimentation included the following activities: (1) market investigation aimed at selecting burner manufacturers who were interested in a further development of high-concentration CWM combustion technology; (ii) selection of a plant with characteristics meeting the research objectives along the general lines suggested by the burner manufacturers; (iii) adjustments in the boiler selected for the experimentation and installation of the necessary instruments; (iv) development of a research methodology aimed first at determining an optimum configuration of the burner's and boiler's functional parameters and then at collecting the operating data in steady operating conditions; (v) trials execution; (vi) analysis of the results and issuing of a final report.

32117 (EUR–12010-EN) **Effect of blast furnace coal injection upon bosh coke properties, coke combustion and furnace permeability.** Williams, R.R.; Fellows, P.M. British Steel Corp., London (UK). 1988. 157p. Available from Commission of the European Communities, Luxembourg.

A single tuyere rig was modified for coal injection studies using a wide range of coal types, size grading and levels of injection. The effect of varying blast operating conditions during coal injection on coal combustion, raceway size and action was investigated. In general coal injection increased blast pressure, raceway size and instability while reducing raceway temperature and blast kinetic energy. Although coal injection brought about increases in the level of fines production, the overall size changes in the vessel were small. The petrographic examination of the fines showed that coal injection contributed directly in terms of uncombusted injected coal residue, and indirectly in terms of increasing levels of mechanical action in the active regions of the coke bed, and weakening of the coke by coal ash/slag interaction with the coke surface. In general, the extent of these effects decreased with increasing injectant coal rank and to a lesser extent with increasing grain size. Increasing blast temperature during coal injection produced a further increase in raceway size and instability with both granular and PF grade coal when compared with the coke-only case. Oxygen enrichment simply acted as a correction for the fall in raceway temperature.

32118 (SAND–90-8223) **Coal Combustion Science quarterly progress report, January–March 1990.** Hardesty, D.R. (ed.). Sandia National Labs., Livermore, CA (USA). May 1990. 110p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC04-76DR00789. Order Number DE90010326. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This document provides a quarterly status report of the Coal Combustion Science Program that is being conducted at the Combustion Research Facility, Sandia National Laboratories, Livermore, California. The information reported is for the period January-March 1990. Characterization of the physical and chemical processes that constitute the early devolatilization phase of coal combustion as a function of coal type, heating rate, particle size and temperature, and gas phase temperature and oxidizer concentration; characterization of the physical and chemical processes involved during combustion as a function of coal type, particle size and temperature, and gas phase temperature and oxygen concentration; and the mechanisms and rates of transformation of mineral matter in coal combustion environments as a function of coal type, particle size and temperature, the initial forms and distribution of mineral species in the unreacted coal, and the local gas temperature and composition. A particular goal is determining the importance of fragmentation in the evolution of the particle size distribution during coal combustion. References and figures are included with each section.

32119 **Transient group combustion: Steady state simulation and transient results.** Ramalingam, S.C. (Texas A and M Univ., College Station, TX (USA). Dept. of Mechanical Engineering); Annamalai, K. 492-498 of Proceedings of the 1987 spring technical meeting of the Combustion Institute on combustion fundamentals and applications. Combustion Institute, Pittsburgh, PA (USA) (1987). (CONF-870541–: Combustion fundamentals and applications: spring technical meeting of the Central States Section of the Combustion Institute, Argonne, IL (USA), 11-12 May 1987).

While most of the experiments are performed with a cloud of particles, the theoretical modelling used to compare and interpret the experimental data are based on the modelling of combustion of individual coal particles. As opposed to individual particle modelling, a group theory is proposed for the combustion modelling of char/carbon particles. To gain a basic understanding of the group behavior, a simple model such as the analysis of a spherically symmetric cloud of char/carbon particles burning in quiescent air, is presented here. Each particle within the cloud produces CO due to both the oxidation of C to CO and the reduction of CO_2 to CO which subsequently oxidizes to CO_2 in the homogeneous gas phase. Using a computer code developed for the study of transient group combustion, steady state was simulated. Firstly, the simulated steady state results were then compared with the explicit results generated in the previous work. The results presented here are for the frozen case where the gas phase CO oxidation reaction and the CO_2 reduction reaction at the char surface are suppressed. This task was undertaken to prove the reliability of the computer model to generate transient results, as there exists no literature on transient group combustion. Secondly, the transient

results for G = 100 and G = 10 are also included to show the comparison with the steady state results for the same conditions.

32120 **Reduction of ash sticking in direct coal-fired gas turbine engines.** Bourke, R.C. (General Motors Corp., Indianapolis, IN (USA). Allison Gas Turbine Div.). 1060-1067 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890916--: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

Considerable effort has been expended to reduce ash deposition by the use of additives that raise ash fusion temperatures and also react with alkali metal oxides, specifically those of sodium (Na) and potassium (K). An initial screening program, utilizing thermoanalysis techniques in addition to standard ash fusion procedures, resulted in the selection of five potential coal dopants that should be evaluated further. The dopants are alumina, magnesia, kaolin, strontia, and silica. Alumina was the most effective, followed by the other four decreasing in effectiveness in the order shown. because of the relatively high cost of magnesia and low effectiveness of strontia and silica, further evaluation was concentrated on alumina and kaolin. This paper describes the evaluation of those two additives and their effectiveness in the prevention of ash sticking on critical gas turbine construction materials.

0150 Economic, Industrial, and Business Aspects

Refer also to citation(s) 32043, 32061, 32080, 32097, 32109, 32470

32121 (DOE/EIA–0121(89/4Q)) **Quarterly coal report, October–December 1989.** USDOE Energy Information Administration, Washington, DC (USA). Office of Coal, Nuclear, Electric and Alternate Fuels. 7 May 1990. 144p. Sponsored by U.S. DOE Energy Information Administration. Order Number DE90010935. Available from NTIS, PC A07/MF A01 - GPO - OSTI; GPO Dep.

The Quarterly Coal Report provides comprehensive information about US coal production, exports, imports, receipts, consumption, and stocks to a wide audience, including Congress, Federal and State agencies, the coal industry, and the general public. This issue presents detailed quarterly data for October through December 1989, aggregated quarterly historical and projected data for 1981 through 1991, and aggregated annual historical and projected data for 1960 through 2010. Appendix C displays, from 1980 on, detailed quarterly historical coal imports data, as specified in Section 202 of the Energy Policy and Conservation Amendments Act of 1985 (Public Law 99-58). Appendix D gives selected quarterly tables converted to metric tons. To provide a complete picture of coal supply and demand in the United States, historical information and forecasts have been integrated in this report. 7 figs., 37 tabs.

0160 Health and Safety

32122 (CRIEPI-U–89018) **Biological effects of combined exposure to coal fly ash and nitrogen dioxide.** Nishimura, I. (and others). Central Research Inst. of Electric Power Industry, Abiko, Chiba (Japan). 1989. vp. (In Japanese). Available from Central Research Institute of Electric Power Industry, Tokyo (Japan).

Golden hamsters were exposed to combined air pollutants, 2mg/m^3 of coal fly ash (FA) and 4ppm of nitrogen dioxide (NO_2) for 90 days or 0.4ppm for 180 days to clarify the biochemical changes of the whole lungs. Periodical changes of lipid peroxide (TBA value), antioxidative effect (NPSH), antioxidative enzyme activities (GPx, G6PDH), enzyme activities of energy-generating system (PK, SCR), collagen content (HOP) and collagen metabolising enzyme (PZP) were examined. In 4ppm NO_2 alone exposed group, TBA value increased at the beginning of exposure, then decreased to the control level. On the other hand, in 0.4 ppm NO_2 alone exposed group, it increased only after 180 days of exposure. The amount of NPSH in 4 ppm NO_2 group remained high compared to the control group throughout the exposure and specific activities of G6PDH, GPx, PK, SCR and PZP increased at the beginning of exposure but decreased to control level after 60 days. NPSH increased after 180 days of exposure in 0.4 ppm NO_2 group, but other metabolic activities showed little change during the exposure. In FA alone exposed group, no changes were observed until both day of exposure, but both TBA value and amount of NPSH increased only after 180 days. G6PDH activity increased at the beginning of exposure and remained the same throughout the exposure period. PK activity was at the same level as the control group. SCR and PZP activities decreased after 90 days of exposure and GPx activity decreased markedly after 60 days of exposure. Combined exposure group showed two different phases in the changes of metabolic activities over time. The first phase changes for initial 30 days of the exposure were similar to those occuring in NO_2 alone exposed group. The changes in second phase after 60 days of exposure were similar to those occurring in FA alone exposed group.

02 PETROLEUM

0202 Reserves, Geology, and Exploration

Refer also to citation(s) 32134, 32160, 32168, 32169, 32170, 33116, 33261

32123 (DOE/PO/07196–T1) **SPR conceptual design: Supplement to salt dome geology and cavern stability analysis, Bayou Choctaw, Louisiana: Department of Energy Strategic Petroleum Reserve Program, Bayou Choctaw, Louisiana.** PB/KBB, Harahan, LA (USA). Sep 1978. 106p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC96-78PO07196. Order Number DE90011031. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The findings and results of the Strategic Petroleum Reserve (SPR) Conceptual Design are summarized. The main body of the report includes a master schedule for design, construction, leaching and filling, process and piping system description, cavern design and leaching analysis, electrical and instrumentation systems description, list of long lead equipment and a cost estimate.

32124 (IKU-R–34.2783.03/01/89) **Permeability patterns in some fluvial sandstones: An outcrop study from Yorkshire, North East England.** Jacobsen, T.; Rendall, H. Institutt for Kontinentalundersoekelser og Petroleumsteknologi A/S, Trondheim (Norway). Oseanografisk Senter. May 1989. 28p. Order Number DE90791377. Available from NTIS (US Sales Only), PC A03/MF A01.

The distribution of permeability in some fluvial sandbodies (lenticular bedded sheet sandstone, lateral accretion-bedded sandstone and crevasse splay complex) in The Middle Jurassic Scalby Formation was measured on two-dimensional outcrops with a minipermeameter. Additionally plugs for laboratory measurements of porosity/permeability were also drilled out at some of the individual sample locations. Thin section analyses in a scanning electron microscope equipped with an image analysing program were performed on the same plugs to study the level and pattern of diagenesis. Field notes on descriptive sedimentary facies (texture and structures) were recorded at each measurement point, but no close association between permeability and these particular properties is apparent. Instead there seem to be a significant relationship between genetic sedimentary facies (type of sandbody) and permeability. Permeabilities in the lenticular bedded sheet sandstone (braided river) are much higher than in the lateral accretion-bedded sandstone (meandering channel), which in turn have higher permeabilities than the crevasse splay. The variation in permeability between sandbodies seems to be influenced by varying degrees of quartz cementation in the differnt genetic sandbodies. Permeability within this fluvial sequence therefore is significantly influenced by differential cementation which is more related to the genetic sedimentary facies than to the textural aspects of the initially deposited sediment. 14 refs., 10 figs., 3 tabs.

32125 (IKU-R–34.2802.02/01/89) **Parameters influencing porosity in sands and sandstones.** Lundschien, B. Institutt for Kontinentalundersoekelser og Petroleumsteknologi A/S, Trondheim (Norway). Oseanografisk Senter. Mar 1989. 28p. Order Number DE90791379. Available from NTIS (US Sales Only), PC A03/MF A01.

Most of the available literature dealing with porosity in sands and sandstones were investigated to find a relationship between porosity and the textural parameters. Sorting was found to be the most important parameter. Grain-size, grain-shape, packing and grain-orientation also influence porosity, but play only subordinate roles. One appropriate mathematical expression of porosity as a function of sorting was found. In consolidated sandstones porosity is also influenced by compaction, authigenesis of minerals, and leaching. 18 refs.

32126 (PB–90-181439/XAB) **Petroleum system: Status of research and methods, 1990. Bulletin.** Magoon, L.B. Geological Survey, Menlo Park, CA (USA). 1989. 98p. (USGS-BULL–1912). Available from NTIS, PC A05/MF A01.

Also available from Supt. of Docs.; Library of Congress catalog card No. 89-600765.

The publication of 17 individually authored summaries by U.S. Geological Survey scientists presents a revised and expanded list of the petroleum systems within the United States and summarizes the status of research for a number of petroleum-related topics and investigative methods. The revised and expanded list now includes 130 petroleum systems within the United States, 25 of which are classified as known systems.

32127 Critical heterogeneities in a barrier island deposit and their influence on various recovery processes. Sharma, B. (Natl. Inst. for Petroleum and Energy, Bartlesville, OK (US)); Honarpour, M.M.; Szpakiewicz, M.J.; Schatzinger, R.A. *SPE Formation Evaluation (Society of Petroleum Engineers) (USA),* 5(1): 103 (Mar 1990).

This paper synthesizes geologic information, acquired from the literature and field studies, and provides detailed maps of geologic heterogeneities, obtained from log and core data, of the Bell Creek field, MT. Geologic heterogeneities were correlated with fluid production data to identify the heterogeneities that have a dominant effect on fluid production. Integration of new and existing information from various geological, geophysical, and engineering disciplines allowed the authors to identify heterogeneities that influence production during different recovery operations.

0203 Drilling and Production

Refer also to citation(s) 32127, 32147, 32300, 33007

32128 (AD-A–217445/6/XAB) **Capillary suction-time tests on selected clays and shales. Master's thesis.** Hart, K.M. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). May 1989. 96p. (AFIT/CI/CIA–89-097). Available from NTIS, PC A05/MF A01.

Shale stability has been an ongoing problem in the drilling of oil wells. The Capillary Suction Time test is simple and easy to use, allowing operators to conduct the test at the rigsite. However because of difficulty in reproducing results, the test should be used only qualitatively. The CST, along with the Methylene Blue, Specific Surface Area and Ensilin tests, accurately predicts shale swelling and dispersion. The tests have the added advantage of being able to be conducted relatively quickly. These tests could be carried out at the rigsite while the drilling is taking place. The experiments conducted also demonstrated the usefulness of KCL as an inhibitor of shale swelling and dispersion. From the CST data, it can be seen that KCL concentrations as low as 0.5% are effective in controlling the swelling of Phillips Ekofisk, Phillips Andrews County, Texaco Mississippi Canyon and Pierre Texaco. However a greater concentration of KCL is required to inhibit the swelling of Gold Seal Bentonite, Standard Arizona, Standard Wyoming and Standard Texas. It is recommended that more concentrations of KCL be tested of the high swelling clays to determine the minimum concentration required to inhibit swelling and dispersion.

32129 (DOE/BC/14126–18) **A comparison of relative permeability from centrifuging versus coreflooding.** Shimbo, D.T. Stanford Univ., CA (USA). Petroleum Research Inst. May 1990. 173p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-87BC14126. (SUPRI-TR–72). Order Number DE90000234. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

Relative permeability and capillary pressure data from both centrifuge and coreflooding experiments on the same Berea sandstone will be analyzed using both analytical and simulation techniques. A linear two phase simulation model of fluid displacement from a core will be built. Capillary, gravity, and viscous effects will be included. 27 refs., 36 figs.

32130 (IFP–37-479) **Contribution to the analytical and numerical evaluation of oil well equilibrium for any cross section under a uniform pressure and an anisotropic stress field.** Bouziane, A. Institut Francais du Petrole (IFP), 92 - Rueil-Malmaison (France); Nantes Univ., 44 (France). Sep 1989. 197p. (In French). Order Number DE90790593. Available from NTIS (US Sales Only), PC A09/MF A01.

The integral equation, the finite element and an analytical method are used and compared to compute the state of equilibrium of an oil well. This well is of whatever cross section and is subjected to a uniform pressure and an anisotropic stress field at the infinity. In the first part, the equations of the Mechanics of deformable solids are recalled using dual vectorial spaces theory. These equations are briefly introduced by using a four spaces diagram. In the second part, an analytical method using the complex potentials developed by Muskhelishvili is used to solve the problem. In the third part, three methods of integral equations are developed (direct and indirect). The stress boundary conditions at infinity are taken into account by superimposing a particular solution to the fundamental solution. With such a method, both displacements and stresses are correctly represented as well on the boundary as inside the domain. The finite element method is developed in the fourth part. For complicate shapes of well cross section the used automatic mesh generator does not seem well adapted. In conclusion, the integral equation method gives the results which are in the best agreement with the analytical solutions.

32131 (IKU-R–31.8842.00/01/89) **Three-dimensional permeability and fluid flow.** Akervoll, I.; Holt, R.M.; Moum, J. Institutt for Kontinentalundersoekelser og Petroleumsteknologi A/S, Trondheim (Norway). Oseanografisk Senter. Apr 1989. 22p. Order Number DE90791375. Available from NTIS (US Sales Only), PC A03/MF A01.

The report summarizes the first year's activities in a three year research program investigating permeability and fluid flow in anisotropic and heterogeneous reservoir formations. The program was initiated by the Norwegian Council for Scientific and Industrial Research (NTNF) as an advanced technology program involving enchanced oil recovery and sophiaticated instrumentation. Three-dimensional pore structure analysis has been performed by scanning electron microscope (SEM) studies of thin sections sequencies from a sandstone. Compaction effects during cementation and the effect of external stress on permeability has been investigated experimentally. Computer modeling has established the basis for making a physical three-dimensional model of a heterogeneous reservoir. 4 figs.

32132 (OTH–89-302) **Sensitivity study of member stresses to current profile variations.** Department of Energy, London (UK); Atkins Oil and Gas Engineering Ltd., London (UK). 1989. 39p. Available from H.M. Stationery Office, London, price Pound 25.50.

A typical 4-legged southern North Sea quarters platform located in a nominal water depth of 120 ft has been analysed for 4 different current profiles. The structural design checks undertaken indicate that resultant changes in magnitude of global loading is a good indicator of design sensitivity for primary structural elements. This is particularly the case for the sensitivity to changes in wave phase angles alone (i.e. wave step position) although there is a very slight degradation in this relationship for current profiles with high near-surface shears. For elements which are not designed by consideration of global loading alone (i.e. top of jacket and mudline framing) it should be recognised that whilst changes in magnitude of global loading is a good indicator of the mean value of design sensitivity, individual elements may reflect a code check change which is many times the mean value change. (author).

32133 (PB–90-182353/XAB) **Absorption properties of carbon dioxide enhanced-oil-recovery additives. Final Technical report, 12 May 1987-31 August 1989.** Patton, J.T.; Holbrook, S.T.

New Mexico State Univ., Las Cruces, NM (USA). Dept. of Chemical Engineering. Jan 1990. 67p. (NMERDI-2-75-5231). Available from NTIS, PC A04/MF A01.

The selection of the optimum foaming agent (surfactant) for enhancing oil production by carbon dioxide flooding is based on foamability and adsorption. Measurement of adsorption on carbonate cores from New Mexico reservoirs showed large adsorption differences between three commercial, high-foaming surfactants. An ethoxylated alcohol structure was least adsorbed, 0.64 mg/cc pore volume; an ethoxylated alcohol sulfate was next, 0.74 mg/cc pore volume; the highest adsorbed was a glyceryl sulfonate, 2.30 mg/cc pore volume. Commercial application of the foaming additive involves injecting alternate slugs of surfactant solution and carbon dioxide. Surfactant concentration should be determined to allow for the adsorption above.

32134 **A comparison of pressure-transient and tracer-concentration/time data for layered reservoirs under injection.** Mishra, S. (INTERA Technologies, Inc., Houston, TX (USA)); Ramey, H.J. Jr. *SPE Formation Evaluation (Society of Petroleum Engineers) (USA)*, 5(1): 60-66 (Mar 1990).

This paper reports hypothetical tracer and pressure-transient test responses computed for a production well in a developed, five-spot, unit-mobility-ratio injection/production pattern. The reservoir was a noncommunicating Dykstra-Parsons layers system. Layer effects were evident in tracer results, but pressure-transient results indicated a single layer of averaged properties. Conventional layer system humps were not present for the buildup pressure-transient data.

32135 **Prediction of miscible flood performance: The effect of dispersion on composition paths in ternary systems.** Walsh, B.W. (Sydney Univ. (Australia). Dept. of Chemical Engineering); Orr, F.M. Jr. *In Situ (USA)*, 14(1): 19-48 (1990).

The interaction of phase behavior with dispersive mixing is examined for one-dimensional flow of ternary, two-phase mixtures. For multicontact miscible systems, the quantitative impact of a given level of dispersion (numerical or physical) on displacement composition path is shown to depend on the size and shape of the two-phase region on a ternary diagram. Displacements for systems in which the bubblepoint and dewpoint portions of the binodal curve are nearly parallel are much more sensitive to the effects of dispersion than are systems in which the bubblepoint and dewpoint loci converge toward the plait point. Comparison of solutions obtained by finite differences and by the method of characteristics indicates that a competition between dispersion and sharpening behavior of the leading shock establishes a composition in the two-phase region. Once that composition is established, the subsequent composition path follows that calculated by the method of characteristics.

0204 Processing

Refer also to citation(s) 32053, 32078, 32079, 32266

0206 Health and Safety

32136 (EGG-10617-1051) **Vapor Barrier Assessment Program for delaying and diluting heavier-than-air hydrogen fluoride vapor clouds: Summary report.** Industry Cooperative Hydrogen Fluoride Mitigation/Assessment Program (USA). Vapor Barrier Subcommittee. Jun 1989. 24p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC08-88NV10617. Order Number DE90011212. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A three-phase research program was conducted as one technical component of the Industry Cooperative HF Mitigation/Assessment Program (ICHMAP) to assess the effectiveness of vapor barriers in delaying and diluting accidental releases of heavier-than-air (HTA) hydrogen fluoride (HF) vapor clouds in an industrial plant setting. Results of this program are applicable to aerosol releases of HF but not to liquid pool or non-HTA vapor HF releases. Such barriers might have potential application as a technique to mitigate the consequence of accidental releases of HF and other HTA vapor clouds. This research program also assessed what, if any, impact such barriers might have on the consequences of an unconfined vapor cloud explosion. Phase 1 consisted of two independent literature reviews of previous work related to the impact of vapor barriers on HTA cloud dilution and transport time. Phase 2 consisted of a literature search to determine what is known about the impact of vapor barriers on flammable cloud explosion overpressures and a series of computer simulations to quantify the impact of vapor barriers on explosion overpressures. Phase 3 consisted of a series of over 200 wind tunnel simulations to quantify the impact of plant obstacles and mitigation barriers on downwind concentrations and cloud transport times.

32137 (EGG-10617-1052) **Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 1, Detailed report.** Petersen, R.L.; Ratcliff, M.A. Cermak Peterka Petersen, Inc., Fort Collins, CO (USA). Jun 1989. 75p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC08-88NV10617. Order Number DE90011206. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

A three-phase research program was conducted as one technical component of the Industry Cooperative HF Mitigation/Assessment Program (ICHMAP) to assess the effectiveness of vapor barriers in delaying and diluting accidental releases of heavier-than-air (HTA) hydrogen fluoride (HF) vapor clouds in industrial plant settings. Such barriers might have potential application as a technique to mitigate the consequences of accidental releases of HF and other HTA vapor clouds. Because one potential application of such barriers might be in an HF alkylation plant where there is also the potential for releases of flammable hydrocarbons, this research program also assessed what impact, if any, such barriers might have on the consequences of an unconfined vapor cloud explosion. This report presents the results from Phase 3 of the research program that consisted of a series of over 200 wind tunnel simulations using a surrogate gas for HF to quantify the impact of plant obstacles and mitigation barriers on downwind concentrations and cloud transport times. All simulations were of transient HTA releases of simulated HF. Barrier performance was judged based on concentrations measured downwind of the release averaged over 1 minute (full scale). 25 refs.

32138 (EGG-10617-1053) **Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 2, Figures and tables for the detailed report.** Petersen, R.L.; Ratcliff, M.A. Cermak Peterka Petersen, Inc., Fort Collins, CO (USA). Jun 1989. 229p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC08-88NV10617. Order Number DE90011211. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

A three-phase research program was conducted as one technical component of the Industry Cooperative HF Mitigation/Assessment Program (ICHMAP) to assess the effectiveness of vapor barriers in delaying and diluting accidental releases of heavier-than-air (HTA) hydrogen fluoride (HF) vapor clouds in industrial plant settings. Such barriers might have potential application as a technique to mitigate the consequences of accidental releases of HF and other HTA vapor clouds. Because one potential application of such barriers might be in an HF alkylation plant where there is also the potential for releases of flammable hydrocarbons, this research program also assessed what impact, if any, such barriers might have on the consequences of an unconfined vapor cloud explosion. This report presents the results (figures and tables) from Phase 3 of the research program that consisted of a series of over 200 wind tunnel simulations using a surrogate gas for HF to quantify the impact of plant obstacles and mitigation barriers on downwind concentrations and cloud transport times. All simulations were of transient HTA releases of simulated HF. Barrier performance was judged based on concentrations measured downwind of the release averaged over 1 minute (full scale). 89 figs., 5 tabs.

32139 (EGG-10617-1054) **Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 3, Appendices A-G.** Petersen, R.L.; Ratcliff, M.A. Cermak Peterka Petersen, Inc., Fort Collins, CO (USA). Jun 1989. 343p. Sponsored

by U.S. DOE Fossil Energy. DOE Contract AC08-88NV10617. Order Number DE90011213. Available from NTIS, PC A15/MF A01; OSTI; Order software packages from National Energy Software Center, Argonne National Laboratory, 9800 South Cass Avenue, Argonne, IL 60439. Order documentation without complete package from NTIS; GPO Dep.

Report includes 1 diskette designed to operate on an IBM PC or compatible equipment.

A three-phase research program was conducted as one technical component of the Industry Cooperative hydrogen fluoride (HF) Mitigation/Assessment Program (ICHMAP) to assess the effectiveness of vapor barriers in delaying and diluting accidental releases of heavier-than-air (HTA) HF vapor clouds in industrial plant settings. Such barriers might have potential application as a technique to mitigate the consequences of accidental releases of HF and other HTA vapor clouds. One potential application might be in an HF alkylation plant. This program also assessed what impact barriers might have on the consequences of an unconfined vapor cloud explosion. This report consists of appendices on model and full scale parameters; comparison of laboratory and field experiments; documentation; observed vapor box clear-out times; tabulation of concentration measurement results; lotus spreadsheet for concentration data base; and videotape summary of selected simulations. (CBS)

32140 (EGG–10617-1055) **Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 4, Appendix H, Concentration contours in the Y-Z plane.** Petersen, R.L.; Ratcliff, M.A. Cermak Peterka Petersen, Inc., Fort Collins, CO (USA). Jun 1989. 579p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC08-88NV10617. Order Number DE90011220. Available from NTIS, PC A25/MF A01 - OSTI; GPO Dep.

A three-phase research program was conducted as one technical component of the Industry Cooperative hydrogen fluoride (HF) Mitigation/Assessment Program (ICHMAP) to assess the effectiveness of vapor barriers in delaying and diluting accidental releases of heavier-than-air (HTA) hydrogen fluoride (HF) vapor clouds in industrial plant settings. Such barriers might have potential application as a technique to mitigate the consequences of accidental releases of HF and other HTA vapor clouds. Because one potential application of such barriers might be in an HF alkylation plant where there is also the potential for releases of flammable hydrocarbons, this research program also assessed what impact, if any, such barriers might have on the consequences of an unconfined vapor cloud explosion. This report presents concentration contours of HF in the Y-Z plane (various combinations of barrier types and different site tapos). 577 figs. (CBS)

32141 (EGG–10617-1056-Vol.1) **Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A review of previous related work: Volume 1, Detailed report.** Petersen, R.L.; Ratcliff, M.A. Cermak Peterka Petersen, Inc., Fort Collins, CO (USA). Oct 1988. 40p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC08-88NV10617. Order Number DE90011205. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The overall purpose of this three phase study (note: the second phase deals with cloud flammability concerns and is not a part of the CPP project) is to assess the effect of vapor barriers in diluting and delaying heavier-than-air (HTA) hydrogen fluoride (HF) vapor clouds. The first phase, which is the subject of this report, consisted of obtaining, reviewing and analyzing existing field and laboratory data bases. Three data bases (Thorney Island Phase 1, 2, and 3 Heavy Gas Dispersion Trails, Neff and Meroney (1986) pre-field wind tunnel tests for the Falcon LNG field tests, and Petersen and Ratcliff (1988) API surface roughness effects evaluation) were analyzed. For the Thorney Island and Neff and Marionette data bases, continuous concentrations were measured so that peak concentrations, peak arrival times, cloud arrival times and cloud durations could be assessed. For the Petersen and Ratcliff data base, continuous released were evaluated and average concentrations were measured; therefore, peak times, etc. could not be evaluated. From the Thorney Island data base, the effect of the following obstructions could be assessed: (a) a 5 m semi-circular fence; (b) a 9 m isolated cubic building up and downwind of the release; (c) a semi-circular 10 m porous screen; and (d) a 2.4 rectangular enclosure. The Neff and Meroney (1986) data base studied the effect of a 44 by 88 m enclosure with a 9.4 m height and 14.1 and 9.4 m vortex-generating walls directly upwind of the release. The Petersen and Ratcliff (1988) data base studied the effect of natural occurring barriers (designated as the API tank farm and API process unit) and homogeneous type surface roughness ranging from grasslands to the center of a city. 16 refs., 45 figs., 9 tabs.

32142 (EGG–10617-1056-Vol.2) **Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A review of previous related work: Volume 2, Tables and figures for the detailed report, and Appendices A and B.** Petersen, R.L.; Ratcliff, M.A. Cermak Peterka Petersen, Inc., Fort Collins, CO (USA). Oct 1988. 120p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC08-88NV10617. Order Number DE90011207. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

A three-phase hydrogen program was conducted as one technical component of the Industry Cooperative hydrogen fluoride (HF) Mitigation/Assessment Program (ICHMAP) to assess the effectiveness of vapor barriers in delaying and diluting accidental releases of heavier-than-air (HTA) hydrogen fluoride (HF) vapor clouds in industrial plant settings. Such barriers might have potential application as a technique to mitigate the consequences of accidental releases of HF and other HTA vapor clouds. Because one potential application of such barriers might be in an HF alkylation plant where there is also the potential for releases of flammable hydrocarbons, this research program also assessed what impact, if any, such barriers might have on the consequences of an unconfined vapor cloud explosion. This report consists of figures, tables, and appendices from simulations of HF release using the Thorney Island data base and Neff and Meroney data base. 45 figs., 11 tabs.

32143 (EGG–10617-1057) **Analysis of vapor barrier experiments to evaluate their effectiveness as a means to mitigate HF concentrations.** Meroney, R.N.; Neff, D.E.; Shin, S.H.; Steidle, T.C.; Tan, T.Z.; Wu, G. Colorado State Univ., Fort Collins, CO (USA). Feb 1989. 192p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC08-88NV10617. Order Number DE90011221. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

Accidental releases of Hydrogen Fluoride (HF) can result in initially dense, highly reactive and corrosive gas clouds. These clouds will typically contain a mixture of gases, aerosols and droplets which can be transported significant distances before lower hazard levels of HF concentration are reached. Containment fences or vapor barriers have been proposed as a means to hold-up or delay cloud expansion, elevate the plume downwind of the barriers, and enhance cloud dilution. Previous related field and laboratory experiments have been analyzed to estimate the effectiveness of barrier devices. The experiments were examined to determine their relevance to Hydrogen Fluoride spill scenarios. Wind tunnel and field data were compared where possible to validate the laboratory experiments. Barrier influence on peak concentrations, cloud arrival time, peak concentration arrival time, and cloud departure time were determined. These data were used to develop entrainment models to incorporate into integral and depth averaged numerical models. The models were then run to examine barrier performance for a typical Hydrogen Fluoride spill for a wide range of vapor barrier heights, spill sizes meteorological conditions and release configurations. Finally the results of the data analysis and numerical sensitivity study were interpreted and expressed in a form useful to evaluate the efficacy of vapor barrier mitigation devices. 103 refs., 146 figs., 6 tabs.

32144 (EGG–10617-1058) **Literature review of work related to impact of barriers on flammable cloud explosion overpressure: Vapor Barrier Assessment Program, Phase 2, Task 1.** Bjerketvedt, D.; Bakke, J.R. Christian Michelsens Inst. for Vitenskap og Aandsfrihet, Bergen (Norway). Jun 1989. 37p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC08-88NV10617. Order Number DE90011209. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Literature addressing the impact of barriers and fences on the consequences of vapor cloud explosions of hydrogen fluorides is

reviewed. The report is one of several work products generated by the Industry Cooperative HF Mitigation/Assessment Program. 11 refs., 13 figs., 2 tabs.

32145 (EGG–10617-1059) **Industry Cooperative Hydrogen Fluoride Mitigation & Ambient Impact Assessment Program: Summary report.** Industry Cooperative Hydrogen Fluoride Mitigation/Assessment Program (USA). Steering Committee. Jul 1989. 35p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC08-88NV10617. Order Number DE90011208. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The three-component Industry Cooperative HF Mitigation/ Assessment Program (ICHMAP) was conducted to study and test techniques for mitigating accidental releases of hydrogen fluoride (HF) and alkylation unit acid (AUA) and to improve tools used to estimate ambient impacts from such releases. The three program components and their major objectives are: investigation of the effectiveness of water of augmented water application systems in mitigating accidental releases of both HF and AUA; assessment of vapor barriers in delaying and diluting accidental releases of heavier-than-air HF vapor clouds in an industrial setting and determine what impact such barriers might have on the consequences of an unconfined vapor cloud explosion; and development of validated ambient impact assessment computer models for calculating release rates and jet and plume dispersion of accidental releases of HF. 10 refs., 10 figs., 3 tabs.

32146 (EGG–10617-1068) **Numerical simulation of hypothetical gas explosions in a process unit: Effect of vapor barriers on explosion pressure.** Bjerketvedt, D.; Nomes, E.H. Christian Michelsens Inst. for Vitenskap og Aandsfrihet, Bergen (Norway). Jul 1989. 172p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC08-88NV10617. Order Number DE90011210. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Numerical simulations of gas explosions in a hydrogen fluoride alkylation plant have been undertaken. The impact of a vapor barrier on the consequences of an UVCE has been addressed. The report is one of several work products generated by the Industry Cooperative HF Mitigation/Assessment Program. 5 refs., 26 figs., 2 tabs.

0207 Economic, Industrial, and Business Aspects

32147 (DOE/BC/14230–T4) **An evaluation of the known remaining oil resource in the State of Texas: Project on Advanced Oil Recovery and the States.** Interstate Oil Compact Commission, Oklahoma City, OK (USA). c Nov 1989. 201p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88BC14230. Available from Interstate Oil Compact Commission, Box 53127, Oklahoma City, OK 73152.

The purpose of this study is to identify and evaluate available methods for increasing recovery from Texas oil reservoirs and to assess options beneficial to the state for encouraging the widespread application of these post-conventional recovery processes. The specific objectives of the study are to: determine the possible recovery and associated economic benefits of the application of improved recovery processes in major Texas reservoirs; assess potential increases in oil recovery under alternative state policies; identify key segments of the state's resource with the largest future recovery potential; and describe an effective program design for a coordinated state policy of research and development and technology transfer to provide maximum assistance to state operators within fiscal constraints. The analysis estimates the impacts of effective research and development (R&D) programs on oil recovery, state tax revenues, and associated public-sector economic benefits over a range of possible future oil prices. 65 figs., 30 tabs.

32148 (DOE/EIA–0380(90/02)) **Petroleum Marketing Monthly, February 1990.** USDOE Energy Information Administration, Washington, DC (USA). Office of Oil and Gas. 3 May 1990. 178p. Sponsored by U.S. DOE Management & Administration. Order Number DE90010975. Available from NTIS, PC A09/MF A01 - GPO - OSTI; GPO Dep.

The Petroleum Marketing Monthly (PMM) is designed to give information and statistical data about a variety of crude oils and refined petroleum products. The publication provides statistics on crude oil costs and refined petroleum products sales for use by industry, government, private sector analysts, educational institutions, and consumers. Data on crude oil include the domestic first purchase price, the f.o.b. and landed cost of imported crude oil, and the refiners' acquisition cost of crude oil. Sales data for motor gasoline, distillates, residuals, aviation fuels, kerosene, and propane are presented. 12 figs., 49 tabs.

32149 (GAO/RCED–89-70BR) **Energy security: Analysis of studies on economic consequences of an oil import tariff.** General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div. Jun 1989. 35p. Available from US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877 (USA).

This GAO report analyzes why recent studies, done by the Department of Energy and Harvard University's Energy and Environmental Policy Center, reached apparently different conclusions about the economic consequences of a tariff on imported oil. These studies used largely the same cost-benefit approach and data but arrive at different conclusions as to the net economic impact of an oil import tariff. While DOE found that a $10-per barrel tariff results in a net cost to the economy, the Policy Center, under the same scenario, indicates a net benefit to the economy. The DOE and Policy Center studies reached different conclusions principally because their estimates of macroeconomic costs - the impact of the tariff on the Gross National Produce - were based on different assumptions. These assumptions concerned whether governmental actions, such as increasing the money supply or reducing other taxes, would occur and would modify the recessionary effect of an oil tariff.

0208 Waste Management

32150 (PB–90-863036/XAB) **Waste processing and pollution in the chemical and petrochemical industries. March 1983-March 1990 (A Bibliography from the NTIS data base). Report for March 1983-March 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 48p. Available from NTISPC N01/MF N01.

Supersedes PB–89-867352.

This bibliography contains citations concerning techniques and equipment used for pollution control in the chemical and petrochemical industries. Topics include emissions investigations, recycling and materials-recovery studies, and standards for specific industries. Sources, site-hazard evaluations, and the toxicity of specific chemicals are also discussed. (This updated bibliography contains 68 citations, 13 of which are new entries to the previous edition.)

32151 **Assessing inhalation risks from the land treatment of petroleum refining wastes.** Volume 7. Fingleton, D. J. (Argonne National Laboratory, Argonne, IL (USA)); Ozkaynak, H. 18p. Air Pollution Control Assoc., Pittsburgh, PA (USA) (1988). (CONF-880679–: 81. annual meeting of Air Pollution Control Association, Dallas, TX (USA), 19-24 Jun 1988).

88-116.7.

Short communication. PETROLEUM REFINERIES/waste management; CHEMICAL WASTES/environmental impacts; CARCINOMAS/risk assessment; INHALATION; GROUND DISPOSAL; US EPA; ENVIRONMENTAL EXPOSURE PATHWAY; BIOLOGICAL EFFECTS; POLLUTANTS; CARCINOMAS; MONTE CARLO METHOD; HEALTH HAZARDS; STANDARDS; AIR QUALITY; LEACHATES; MATHEMATICAL MODELS

0209 Environmental Aspects

Refer also to citation(s) 32161, 32162

32152 (EGG–10617-2062) **Endangered species program, Naval Petroleum Reserves in California: Annual report FY89.** EG and G Energy Measurements, Inc., Goleta, CA (USA). Santa Barbara Operations. Jan 1990. 55p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC08-88NV10617. Order Number

DE90011192. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Construction and development activities conducted by the U.S. Department of Energy (DOE), Naval Petroleum Reserves in California (NPR-C), at Naval Petroleum Reserve No. 1 (NPR-1) to comply with the Naval Petroleum Reserves Production Act of 1976 potentially threatened the continued existence of four federally-listed endangered species: the San Joaquin kit fox. (Vulpes macrotis mutica), blunt-nosed leopard lizard (Gambelia silus), giant kangaroo rat (Dipodomys ingens) and Tipton kangaroo rat (Dipodomys nitratoides nitratoides). All four are protected under the Endangered Species Act of 1973. DOE is obliged to determine whether actions taken by their lessees on Naval Petroleum Reserve No. 2 (NPR-2) will have any detrimental effects on endangered species or their habitats. The major objective of the Endangered Species Program on NPR-1 and NPR-2 is to provide DOE with the scientific expertise and continuity of programs necessary for continued compliance with the Endangered Species Act. The specific objective of this report is to summarize progress and results of the Endangered Species Program made during Fiscal Year 1989 (FY89). 4 figs., 18 tabs.

32153 (GAO/RCED–89-97) **Drinking water: Safeguards are not preventing contamination from injected oil and gas wastes.** General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div. Aug 1989. 47p. Available from US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877 (USA).

Through underground injection, wastes and other fluids are deposited in porous rock formations below drinking water sources. This paper presents GAO report on EPA safeguards against the contamination of drinking water sources. Although the full extent is unknown, the Environmental Protection Agency is aware of 23 cases nationwide in which drinking water was contaminated by Class II wells, used to dispose of strongly saline water (brines) produced when oil and gas are extracted or in enhanced oil recovery processes. In many of these cases, improperly plugged oil and gas wells in the vicinity of injection wells served as the pathway for brines to reach drinking water. Although EPA requires operators of wells that began operating after the program went into effect to search for and plug any improperly plugged wells in the immediate vicinity of their injection wells, this requirement does not apply to those Class II wells that were operating before the program. Injection wells already operating before the program accounted for nearly all the cases in which contamination has occurred through migration into improperly plugged wells. GAO estimates that at least 70 percent of Class II wells in four states - Kansas, New Mexico, Oklahoma, and Texas - were already operating before the program and therefore have not been subject to the search-and-plug requirement.

32154 (PB–90-165168/XAB) **Fiscal Year 1988 program report: Maine Environmental Studies Center.** White, G.K. Maine Univ., Orono, ME (USA). Environmental Studies Center. Jul 1989. 26p. Available from NTIS, PC A03/MF A01.

See also PB–88-253331.

Groundwater protection continues to be a primary water resource issue in Maine. Concerns have developed as a result of numerous cases of groundwater contamination from hazardous waste sites, underground fuel tanks, and other sources. Maine is seeking new methods of aquifer classification and protection. Geographic information systems appear to be capable of making a significant contribution, by offering improved handling of a variety of geographically oriented information, to the efforts of both State and local governments in dealing with groundwater issues. Radon was a priority research issue for the Center in the late 1970s and early 1980s. Because of the state's bedrock geology, radon levels in well water and in household air are high enough in some Maine homes to entail significant health risks. Maine is unique among the lower forty-eight states in having so many lakes and ponds and so many miles of undeveloped rivers and streams. Numerous conflicts have arisen because of increasing development pressure as well as other factors such as intensified forestry practices, expanding recreational use of inland waters, and more stringent federal drinking water standards.

32155 (PB–90-178195/XAB) **Superfund Record of Decision (EPA Region 7): Arkansas City Dump Site, Arkansas City, Kansas (Second remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 19 Sep 1989. 24p. (EPA/ROD/R–07-89/028). Available from NTIS, PC A03/MF A01.

See also PB–89-182455.

The 200-acre Arkansas City Dump site, in Arkansas City, Cowley County, Kansas, abuts a levee to the west and south which separates the site from the Arkansas River. Between 1916 and 1927, an oil refinery was operated onsite processing between 6,000 and 12,000 barrels of oil per day. After an explosion destroyed the refinery in 1927, the site was used as a municipal landfill. The refinery treated petroleum fractions with sulfuric acid to improve color and to remove asphaltenes, paraffins, and resinous substances generating acid sludge waste in the process. The sludge waste was disposed of onsite in earthen pits in the north waste area and remediation of the area was addressed in a 1988 Record of Decision (ROD), as operable unit one. The second and final operable unit addressed the remainder of the site, which contains subsurface petroleum contaminants trapped in the soil below the water table as a result of petroleum spills. Results from remedial investigations revealed only low levels of soil and ground water contamination due to onsite disposal of municipal wastes. These contaminants, however, are not being released in significant concentrations and do not pose a significant threat to human health or the environment.

32156 (PB–90-178203/XAB) **Superfund Record of Decision (EPA Region 2): FAA (Federal Aviation Administration) Technical Center, Atlantic County, New Jersey (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 26 Sep 1989. 64p. (EPA/ROD/R–02-89/094). Available from NTIS, PC A04/MF A01.

Portions of this document are not fully legible.

The 5,000-acre multipurpose FAA Technical Center site is a Federal Facility eight miles northwest of Atlantic City, in Atlantic County, New Jersey. Atlantic City's municipal water supply is provided by nine ground-water supply wells located just north of the reservoir on FAA property as well as by water drawn directly from the reservoir. Land use in the site vicinity includes forested land and commercial and residential areas. There are 25 known areas of contamination at the FAA Technical Center. Further areas of contamination will be addressed in future Records of Decision. Soil and ground water at the site are contaminated with VOCs apparently attributable to the jet fuel farm. Subsurface jet fuel contamination is probably the result of leaking pipes, storage tanks, and spills associated with above-ground and underground storage tanks, associated valves, piping, and dry wells, or a truck loading stand. As an interim remedial measure, free product recovery pumps were installed in 1988-89 in three onsite wells to recover the hydrocarbon plume floating on the water table. The primary contaminants of concern affecting the soil and ground water are VOCs including benzene, toluene, and xylenes; and other organics including PAHs (naphthalene) and phenols.

32157 (PB–90-183435/XAB) **Enhanced bioremediation utilizing hydrogen peroxide as a supplemental source of oxygen: A laboratory and field study. Final report, August 1987-November 1989.** Huling, S.G.; Bledsoe, B.E.; White, M.V. Environmental Protection Agency, Ada, OK (USA). Robert S. Kerr Environmental Research Lab. Feb 1990. 57p. (EPA–600/2-90/006). Available from NTIS, PC A04/MF A01.

Laboratory and field-scale studies were conducted to investigate the feasibility of using hydrogen peroxide as a supplemental source of oxygen for bioremediation of an aviation gasoline fuel spill. Field samples of aviation gasoline contaminated aquifer material were artificially enhanced with nutrients to promote microbiological degradation of fuel carbon in a laboratory column experiment. The rapid rate of hydrogen peroxide decomposition at 100 mg/l resulted in the production of oxygen gas. An oxygen mass balance indicated that approximately 44% and 45% of the influent oxygen was recovered in aqueous and gaseous phases, respectively. Reduced rates of oxygen consumption during this period indicated that microbial inhibition may have occurred. Ground-water data from the

enhanced in-situ bioremediation pilot field study indicates that hydrogen peroxide successfully increased the concentration of available oxygen downgradient. In the study, however, it was observed that there was a measurable increase of oxygen in the soil-gas area where hydrogen peroxide was injected. This indicated that a significant fraction of hydrogen peroxide rapidly decomposed to oxygen gas and escaped into the unsaturated zone.

32158 (PB–90-186453/XAB) **Superfund Record of Decision (EPA Region 9): Purity Oil Sales, CA. (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 26 Sep 1989. 63p. (EPA/ROD/R–09-89/040). Available from NTIS, PC A04/MF A01.

Portions of this document are not fully legible.

The seven-acre Purity Oil Sales site is in Fresno County, California, one-half mile south of the Fresno city limits. The Purity site operated as a used-oil recycling facility from 1934 to the early 1970s. In 1976, a fire destroyed the main-warehouse building. Equipment remaining, with the exception of seven steel aboveground storage tanks, was removed from the site, and the area was partially regraded. One of the remaining storage tanks is lined with asbestos. Waste pits filled with soil, debris, and rubble cover most of the site. The State conducted a remedial investigation in 1982 during which time the EPA Emergency Response Team removed 1,800 cubic yards of hazardous oily and tarry materials from the site. The first of two planned operable units addresses the cleanup of the ground water and the removal and offsite disposal of storage tanks and tank contents. A future Record of Decision will address contaminated soil. The primary contaminants of concern affecting ground water are VOCs including benzene and TCE; and metals. Contaminants of concern in the tank sludge are VOCs including benzene, toluene, and xylenes; other organics including PCBs, PAHs, pesticides, and phenols; and metals including lead.

32159 (PB–90-187220/XAB) **Assessing UST corrective action technologies: Site assessment and selection of unsaturated zone treatment technologies. Report for October 1987-September 1989.** Lyman, W.J.; Noonan, D.C. Camp Dresser and McKee, Inc., Boston, MA (USA). Mar 1990. 119p. Available from NTIS, PC A06/MF A01.

A methodology is presented for evaluating the likely effectiveness of five soil-treatment technologies at sites where petroleum products have contaminated the unsaturated zone. The five soil-treatment technologies are: soil venting, biorestoration, soil flushing, hydraulic barriers, and excavation. The evaluation consists of a site assessment, selection of a treatment technology, and performance monitoring and follow-up measurements. The overall focus of the manual is on making a preliminary screening of what soil-treatment technologies would likely be effective at a given underground storage-tank site. Factors that are critical to the successful implementation of each technology are presented and site conditions favorable for each factor are discussed.

0220 Transport, Handling, and Storage

Refer also to citation(s) 32123, 33005

32160 (DOE/PO/07196–T2) **Strategic Petroleum Reserve Program: Salt dome geology and cavern stability analysis, Bayou Choctaw, Louisiana: Final report, Appendix.** Thomas, R.L. (Louis Records and Associates, Inc. (USA)); Hendron, A.J. Jr. Parsons, Brinckerhoff, Quade and Douglas, Inc., New York, NY (USA); Louis Records and Associates, Inc. (USA). [1978]. 270p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC96-78PO07196. Order Number DE90011032. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

Data is presented from a geological evaluation of the Bayou Choctaw Salt Dome, Louisiana. Information includes: microgravity surveys; rock mechanical properties testing; geological conditions which included a description and interpretation of field and rock care studies, mineralogical examination, structure of the West Flank and anhydrite-crude oil correlations; and analytical studies. (CBS)

32161 (DOE/PO/10391–T1) **Annual technical report for the onshore environmental baseline characterization.** York Research Consultants, Denver, CO (USA). 15 Aug 1984. 129p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC96-82PO10391. Order Number DE90011029. Available from NTIS, PC A07/MF A01 - OSTI.

An onshore baseline characterization study for six sites presently contained in the Strategic Petroleum Reserve (SPR) network was performed. One year of data was collected at each site to describe the existing background conditions in the vicinity of the Louisiana and Texas Gulf coast area. Air quality and meteorological measurements were taken at six SPR sites. Additionally, a baseline study of vegetation and floral species was performed. This annual technical assessment report contains a summary and results of work performed and a qualitative scientific assessment of air quality, meteorological, and vegetation monitoring performed October 1, 1982, through September 30, 1983. 30 refs., 17 figs., 27 tabs.

32162 (PB–90-185547/XAB) **Detecting leaks: Successful methods step-by-step. Final report.** Beall, C.; McConnell, L.; Nugent, A.; Parsons, J. Environmental Protection Agency, Washington, DC (USA). Office of Underground Storage Tanks. Nov 1989. 235p. (EPA–530/UST-89/012). Available from NTIS, PC A11/MF A02.

This handbook provides basic information on release-detection methods allowed in the final underground-storage-tank rule which include: inventory control, manual tank gauging, tank-tightness testing, automatic tank gauging, vapor monitoring, ground-water monitoring and secondary containment with interstitial monitoring. It provides a brief description and summary of each method along with potential problems that may occur with each and solutions to those problems. The handbook also contains information on piping release-detection methods.

0230 Properties and Composition

Refer also to citation(s) 32078

32163 **Electron beam-induced fluorescence as a liquid chromatographic detection technique.** Dezaro, D.A. (Brookhaven National Lab., Upton, NY (USA). Environmental Chemistry Div.); Springston, S.R.; Schidlovsky, G. 1-1 of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) ([1990]). (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 1053.

Characteristics of the detector such as flow-cell construction, voltage, current, sensitivity, linearity, and selectivity is discussed. the ability to focus an electron beam to small detection volumes (appropriate for microbore HPLC) is also considered. Electron beam-induced fluorescence, in the liquid phase, has been investigated as a chromatographic detection technique. The electron gun from a Siemens TEM was used to produce a stable high energy electron beam (1–50 microamps at 40–100 kilovolts), which impinged upon a specially designed liquid flow-cell. The electron beam penetrated a flow-cell window (4 μM thick) and was dissipated in the liquid mobile phase. The dissipation of electron beam energy produces ionization and excitation of mobile phase molecules, some fraction of which transfer their energy to excite eluting fluorescent molecules. Fluorescence light output was collected through a transparent flow-cell window and monitored by a photomultiplier tube. This prototype detector has been used to monitor fluorescent polyaromatic compounds as they elute from flow injection and HPLC systems. Certain classes of compounds (e.g., nitrated polyaromatics) which produce extremely poor UV-induced fluorescence (or even induce background fluorescence quenching) exhibit excellent detection sensitivity using electron beam-induced fluorescence. Compound specific differences inflorescence output, between UV-induced and electron beam-induced fluorescence, can permit selective multidetector characterization and quantitation of mixtures in some cases of incomplete chromatographic resolution.

32164 A sulfur isotope data analysis of crude oils from the Bolivar coastal fields (BCF), Venezuela. Manowitz, B. (Brookhaven National Lab., Upton, NY (USA)); Premuzic, E.T.; Krouse, H.R.; Barker, C. 16 of Division of Geochemistry, Inc. 197th ACS National Meeting. American Chemical Society, Washington, DC (US) (1989). (CONF-8904133–: Symposium on geochemistry of sulfur in fossil fuels, Dallas, TX (USA), 9-14 Apr 1989).

The BCF of Venezuela, contain at least four major classes of oils, with many that have been subjected to biodegradation. Sulfur isotope data further subdivide the oils into two groups, a slightly biodegraded group with $\delta^{34}S$ values averaging at +7.56 °/₀₀, and a heavily biodegraded group in which $\delta^{34}S$ values average at + 5.1 °/₀₀. During thermal alterations, the oil classes maintain their $\delta^{34}s$ values and lose sulfur. The sulfur content for each class of oil increases linearly with the increase in the asphaltene content. With increasing temperatures sulfur and asphaltene contents decrease linearly, indicating a thermal loss of sulfur and asphaltenes. The biodegraded oils show an increase in C_{15+} content and a decrease in the content of saturates. The observed simultaneous accumulation of sulfur in the biodegraded oils suggests that the sulfur compounds were not biodegraded and the lightening of the sulfur isotope ratios may be due to bacterial reduction of sulfate in the associated waters. The nature of the BCF oils will be discussed in terms of the above observations.

32165 Geoporphyrin analysis using an ion trap mass spectrometer. Van Berkel, G.J. (Oak Ridge National Lab., TN (USA)); Glish, G.L.; McLuckey, S.A. 31 of Division of Geochemistry, Inc. 197th ACS National Meeting. American Chemical Society, Washington, DC (US) (1989). DOE Contract AC05-84OR21400. (CONF-8904132–: American Chemical Society Division of Geochemistry, Dallas, TX (USA), 9-14 Apr 1989).

Data obtained using mass spectrometry has advanced the understanding of porphyrin geochemistry and has been used, for example, in the reconstruction of depositional environments, for determination of sample maturity, and in correlation studies. Work in their laboratory is aimed at developing new and better mass spectrometric techniques to facilitate these types of applications. The Ion Trap Mass Spectrometer (ITMS) has proven to be ideally suited for this work due to its high sensitivity, multiple ionization modes, and capability to perform MS/MS and MS^n (where $n > 2$) experiments. In this paper, the basic theory and operation of the ITMS will be overviewed. Electron ionization and several chemical ionization methods are evaluated for their use in determining porphyrin distributions. Combining ionization methods that minimize porphyrin fragmentation with MS/MS and MS^n analysis is shown to provide detailed structural information on porphyrins within complex mixtures. This added degree of structural information provides a detailed porphyrin fingerprint that might prove valuable in correlation studies.

32166 Comparison of isothermal and nonisothermal pyrolysis data with various rate mechanisms: Implications for kerogen structure. Burnham, A.K. (Lawrence Livermore National Lab., CA (USA)); Braun, R.L.; Taylor, R.W. 40 of Division of Geochemistry, Inc. 197th ACS National Meeting. American Chemical Society, Washington, DC (US) (1989). DOE Contract W-7405-ENG-48. (CONF-8904132–: American Chemical Society Division of Geochemistry, Dallas, TX (USA), 9-14 Apr 1989).

Both multiple-parallel and kerogen-bitumen-oil sequential reaction models are used frequently to model oil generation from kerogen pyrolysis. However, they give fundamentally different predictions for some aspects of oil generation. While Green River oil shales generate bitumen as required by the sequential mechanism, all but one of those they examined did not have the required induction period before maximum oil generation rate at isothermal conditions. The exceptional sample also had a narrower nonisothermal rate profile than that calculated from the E_a derived from shift in T_{max} with heating rate. Fitting the narrow nonisothermal reaction profile leads to an erroneously high E_a. In contrast, the nonisothermal profile of marine kerogens is usually broader than that calculated from the T_{max}-shift E_a, causing E_a derived from fitting the reaction profile to be too low unless a distribution is used. Marine kerogens also form bitumen, and the maximum oil formation rate in isothermal pyrolysis occurs as soon as the material reaches pyrolysis temperature. These apparent mechanistic conflicts are discussed in terms of a highly branched kerogen structure where bitumen and oil formation are related to breaking of different types of chemical bonds. Pyrolysis behavior of kerogens is also compared to that of synthetic polymers.

0250 Combustion

32167 (UCRL–102497-1) **Shock tube ignition of isomers of octane.** Burcat, A. (Technion-Israel Inst. of Tech., Haifa (Israel). Faculty of Aerospace Engineering); Pitz, W.J.; Westbrook, C.K. Lawrence Livermore National Lab., CA (USA). 13 Dec 1989. 23p. Sponsored by U.S. DOE Conservation & Renewable Energy; U.S. DOE Energy Research; United States-Israel Binational Science Foundation. DOE Contract W-7405-ENG-48. (CONF-900704–1: 23. Combustion Institute symposium on combustion, Orleans (France), 22-27 Jul 1990). Order Number DE90005991. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Ignition delay time measurements were carried out behind reflected shock waves for three isomers of octane, including n-octane, 2,2,4-trimethyl pentane, and 2,3,4-trimethyl pentane, and for 1-octene. Initial concentrations of fuel, oxygen, and argon, and the post-shock temperature were varied systematically to establish the influences of these parameters on ignition delay time. A detailed chemical kinetic reaction mechanism was developed to interpret the experimental results. Overall agreement between experimental and computed results was very good, and the model was used to describe the elementary reaction paths by which these fuels ignite and kinetic differences between these closely related hydrocarbon fuels. 22 refs., 5 figs., 3 tabs.

03 NATURAL GAS

0302 Reserves, Geology, and Exploration

Refer also to citation(s) 32106

32168 (DOE/MC/20213–2816-Vol.1) **Subduction zone tectonic studies to develop concepts for the occurrence of sediment subduction (Phase 2): Volume 1: Final report.** Payne, J.; Bandy, B.; Altis, S.; Lee, M.C.; Dwan, S.F.; Ku, K.; Hilde, T.W.C. Texas A and M Univ., College Station, TX (USA). Geodynamics Research Inst. Feb 1989. 240p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-83MC20213. Order Number DE90000473. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

This is volume one of three volumes. The objectives of this study represent a continuation and refinement of the objectives addressed in Phase I. This study focuses on trying to define the tectonics of sediment subduction at the trench axis through the use of accepted plate tectonic principles and the application of new subduction theory. The fundamental methods include: (1) compilation of all available bathymetric data from our Global Marine Geophysical Data Collection for all major ocean trenches, (2) generation of stacked bathymetric profiles and corresponding navigational maps, and structural maps, (3) selection and analysis of appropriate seismic reflection and refraction profiles and additional supporting data such as side-scan sonar, SEABEAM, magnetic, gravity and drilling data, and (4) detailed study of selected trench regions in which data quality and/or quantity is exceptional. Phase II of this project represents a unique compilation and synthesis of existing data for the world's deep ocean trenches. The analysis of data and discussion of results in the context of current literature aids our understanding of the sediment distribution and nature of sediment deformation through various stages of plate convergence, the determination of whether sediments are subducted or accreted, and the evaluation of the controlling factors for sediment subduction and/or accretion. A discussion is included on forearc petroleum and natural gas hydrate resource potential. 128 figs.

32169 (DOE/MC/20213–2816-Vol.2) **Subduction zone tectonic studies to develop concepts for the occurrence of**

sediment subduction (Phase 2): Volume 2: Final report. Payne, J.; Bandy, B.; Altis, S.; Lee, M.C.; Dwan, S.F.; Ku, K.; Hilde, T.W.C. Texas A and M Univ., College Station, TX (USA). Geodynamics Research Inst. Feb 1989. 321p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-83MC20213. Order Number DE90000474. Available from NTIS, PC A14/MF A01 - OSTI; GPO Dep.

The objectives of this study represent a continuation and refinement of the objectives addressed in Phase 1. This study focuses on trying to define the tectonics of sediment subduction at the trench axis through the use of accepted plate tectonic principles and the application of new subduction theory. The fundamental methods include: (1) compilation of all available bathymetric data from our Global Marine Geophysical Data Collection for all major ocean trenches, (2) generation of stacked bathymetric profiles and corresponding navigational maps, and structural maps, (3) selection and analysis of appropriate seismic reflection and refraction profiles and additional supporting data such as side-scan sonar, SEABEAM, magnetic, gravity and drilling data, and (4) detailed study study of selected trench regions in which data quality and/or quantity is exceptional. Phase 2 of this project represents a unique compilation and synthesis of existing data for the world's deep ocean trenches. The analysis of data and discussion of results in the context of current literature aids our understanding of the sediment distribution and nature of sediment deformation through various stages of plate convergence, the determination of whether sediments are subducted or accreted, and the evaluation of the controlling factors for sediment subduction and/or accretion. A discussion on petroleum and natural gas hydrate resource potential is included.

32170 (DOE/MC/20213–2816-Vol.3) **Subduction zone tectonic studies to develop concepts for the occurrence of sediment subduction (Phase 2): Volume 3: Final report.** Payne, J.; Bandy, B.; Altis, S.; Lee, M.C.; Dwan, S.F.; Ku, K.; Hilde, T.W.C. Texas A and M Univ., College Station, TX (USA). Geodynamics Research Inst. Feb 1989. 390p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-83MC20213. Order Number DE90000475. Available from NTIS, PC A17/MF A01 - OSTI; GPO Dep.

The objectives of this study represent a continuation and refinement of the objectives addressed in Phase 1. This study focuses on trying to define the tectonics of sediment subduction at the trench axis through the use of accepted plate tectonic principles and the application of new subduction theory. The fundamental methods include: (1) compilation of all available bathymetric data from our Global Marine Geophysical Data Collection for all major ocean trenches, (2) generation of stacked bathymetric profiles and corresponding navigational maps, and structural maps, (3) selection and analysis of appropriate seismic reflection and refraction profiles and additional supporting data such as side-scan sonar, SEABEAM, magnetic, gravity and drilling data, and (4) detailed study of selected trench regions in which data quality and/or quantity is exceptional. Phase 2 of this project represents a unique compilation and synthesis of existing data for the world's deep ocean trenches. The analysis of data and discussion of results in the context of current literature aids our understanding of the sediment distribution and nature of sediment deformation through various stages of plate convergence, the determination of whether sediments are subducted or accreted, and the evaluation of the controlling factors for sediment subduction and/or accretion. A major emphasis in our analysis of the data was to try and map the seaward-of-the-trench distribution of faults and associated surface roughness. Illustrations and an extensive bibliography are included in the report.

32171 (PB–90-185463/XAB) **Physicochemical properties of methane storage and transport in Devonian shale. Annual technical report, June 1988-May 1989.** Schettler, P.D.; Parmely, C.R. Juniata Coll., Huntingdon, PA (USA). Jun 1989. 85p. Available from NTIS, PC A05/MF A01.

See also PB–88-123088.

This report deals with the determination of how natural gas is stored in Devonian shales and what the theoretical implications of the storage mechanisms are. Isotherm measurements show that approximately 50% of the methane present in shale is either dissolved in other fluids or is adsorbed; the remainder exists as gas in the pore spaces of the shale matrix. The interrelationship of mercury-porosimetry measurements, and helium and methane isotherm determinations are discussed. The possible potential of NMR as a tool for determining the nature of adsorption on the shales is explored. The errors and accuracy of isotherm determination is discussed. Different natural gas components have different isotherms in Devonian shale. One implication of this is that production from fractured reservoirs of shale ought to fluctuate in response to wellbore pressure fluctuations. Relevant results from both an analytical model and a new numerical simulator are presented.

0303 Drilling, Production, and Processing

Refer also to citation(s) 32132

32172 (DOE/MC/24051–2808) **Ground movements associated with gas hydrate production in geologic media: Final report.** Siriwardane, H.J.; Tsai, W.S. West Virginia Univ., Morgantown, WV (USA). Coll. of Engineering. Jun 1989. 154p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG21-87MC24051. Order Number DE90000468. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

This report deals with an investigation on the potential strata movements and subsidence associated with hydrate production. The investigation involved the determination of mechanical properties experimentally and numerical modeling of ground movements resulting from reservoir compaction. The objective was to investigate the influence of reservoir compaction on ground movements based the theories of continuum mechanics and principles of geomechanics. Here, the Finite Element Method was used in modeling the ground movements. This is a powerful computer-based technique which has been widely used in many areas of geomechanics. Parametric studies were performed to establish possible variation in the expected ground movements for different reservoir conditions and material characteristics. The results from this investigation can be useful in estimating the magnitude of ground movement problems associated with hydrate production from geological materials. 45 refs., 17 figs., 13 tabs.

0306 Economic, Industrial, and Business Aspects

Refer also to citation(s) 32179, 32526

32173 (DOE/IG–0282) **Purchase of natural gas by the Albuquerque Operations Office.** USDOE Office of Inspector General, Albuquerque, NM (USA). Western Regional Office. 23 Apr 1990. 14p. Sponsored by U.S. DOE Office of Inspector General. Available from OSTI.

Report to The Secretary.

The purpose of our audit was to determine if the Albuquerque Operations Office (AL) was economically purchasing natural gas for the Department of Energy's (Department) weapons complex. We conducted the audit field work from March 13 to July 7, 1989, and examined pertinent documents available during the period. The audit included the following weapons complex facilities: Sandia National Laboratories (Sandia); Los Alamos National Laboratory (Los Alamos); Rocky Flats Plant; Kansas City Plant; and the Pantex Plant. At AL, we obtained data on gas use at the Mound Plant and Kirtland Air Force Base (Kirtland). We excluded the Department's production plant at Pinellas and the Oxnard facility because of their low volume of natural gas consumption.

32174 (EPRI-P–6821-Vol.1) **Natural gas requirements for electricity generation through 2000: Can the natural gas industry meet them?: Volume 1: Final report.** Jensen, J. (Jensen Associates, Inc., Boston, MA (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Jensen Associates, Inc., Boston, MA (USA). c May 1990. 144p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Because the electric power industry is planning on a major expansion in natural gas generation, and understanding of planning and investment issues is necessary if utilities are to manage this transition successfully. This report focuses on the future supply,

pricing, and risks of gas supply for power generation and the growing interdependence of the electricity and gas industries. The project team evaluated natural gas forecasts to distinguish issues of broad industry agreement from those that remain in controversy. By focusing on major uncertainties, the analysis identified issues critical to future electricity industry operations and planning. The team evaluated gas generation and investment planning issues in depth with selected utilities and more broadly with a larger industry group through a series of regional workshops. 15 refs., 32 figs., 8 tabs.

32175 (EPRI-P-6821-Vol.2) **Natural gas requirements for electricity generation through 2000: Can the natural gas industry meet them?: Volume 2, Appendix B, Gas supply issues: Final report.** Jensen, J. (Jensen Associates, Inc., Boston, MA (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Jensen Associates, Inc., Boston, MA (USA). c May 1990. 55p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Because the electric power industry is planning on a major expansion in natural gas generation, an understanding of planning and investment issues is necessary if utilities are to manage this transition successfully. This report focuses on the future supply, pricing, and risks of gas supply for power generation and the growing interdependence of the electricity and gas industries. 9 figs., 26 tabs.

32176 (PB-90-171349/XAB) **Residential/Commercial Energy Systems 1983-1984 research status report, September 1984.** Gas Research Inst., Chicago, IL (USA). Sep 1984. 229p. (GRI-84/7007). Available from NTIS, PC A11/MF A02.

See also PB-88-173026.

Information on the status (1983-1984) of activities within GRI's Residential/Commercial Energy Systems Subprogram is provided. The funding rationale, goals and objectives, accomplishments and strategies, and contract status are described for projects in these areas: residential and commercial heating systems, residential and commercial heat pumps and prime movers, residential and commercial appliances, cooling systems, building/system performance, phosphoric acid fuel cells, advanced fuel cell concepts, and energy cogeneration systems.

32177 (PB-90-171356/XAB) **Chemical Process Research Department R and D status report. December 1989.** Gas Research Inst., Chicago, IL (USA). Dec 1989. 99p. (GRI-89/0313). Available from NTIS, PC A05/MF A01.

See also PB-89-159974.

The 1989 status report discusses activities within the GRI chemical Process Research Department. The tactical objectives, goals, strategies, and contract status are described for projects within these project areas: Advanced Gas Processing, Coal Gasification, Coal Sciences, Methane Reaction Science, and Advanced Gas Separations and Technology. An appendix contains Technology Briefs on Natural Gas Processing R&D, Basic Coal Sciences Program - Coalbed Methane, An Analytical Tool for Reservoir Gas Content Calculations, and Coal Gasification Kinetics; and a technical paper on the potential economics of advanced separation technology for processing natural gas.

32178 (PB-90-184698/XAB) **Development of a catalytic infrared cooking gas burner.** Tonon, T. Catalytic Energy Corp., Arlington, VA (USA). 22 Sep 1987. 45p. Available from NTIS, PC A03/MF A01.

Color illustrations reproduced in black and white.

The catalytic oxidation of natural gas was investigated for application to an infrared stove-top burner. Project goals were to demonstrate stable catalytic combustion of natural gas in a burner, suitable for use in a stove top, that would have a thermal cooking efficiency of 70%, produce less than 10 ppm NOx and 50 ppm CO concentrations in the flue gas, and have a turndown ratio of five. Calculations were performed to estimate the length of the catalytic coating and burner dimensions; the fluid dynamics of flow through the burner was analyzed in order to size the venturi, and a test rig with two prototypes was constructed. The second prototype exhibited stable catalytic combustion, achieved a peak thermal efficiency of 59%, and satisfied the project goals for NOx and CO emissions.

0308 Environmental Aspects

Refer also to citation(s) 32153, 32172

0320 Transport, Handling, and Storage

32179 (DOE/IG-0283) **The natural gas pipeline servicing Los Alamos National Laboratory.** USDOE Office of Inspector General, Albuquerque, NM (USA). Western Regional Office. 23 Apr 1990. 7p. Sponsored by U.S. DOE Office of Inspector General. Available from OSTI.

Report to The Secretary.

The Albuquerque Operations Office (AL) was responsible for operation of a Department-owned 130-mile natural gas pipeline servicing Los Alamos. The Gas Company of New Mexico (GCNM) had been leasing the Department's pipeline since September 1977. The purpose of the audit was to evaluate the effectiveness of AL's management of the Department pipeline and natural gas service to Los Alamos. Our audit disclosed that AL could save about $1.2 million annually by replacing its gas pipeline lease agreement with an operating, maintenance, and transportation contract. AL could also recover about $100,000 for steam plant gas meter service charges that were not justified and could save about $5,000 annually by negotiating reduced property inlet meter service charges.

32180 (PB-90-864158/XAB) **Natural gas transport by plastic pipes. January 1970-January 1990 (A Bibliography from the COMPENDEX data base). Report for January 1970-January 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 62p. Available from NTISPC N01/MF N01.

Supersedes PB-89-850424.

This bibliography contains citations concerning the use of plastic piping to transport natural gas or liquid-propane gas. The interaction between gas odorants and plastic pipe, the effects of aging on plastic pipe used to transport gas, and pipe-failure analyses are examined. Bending, joining, and repair methods are discussed. Composite reinforced-plastic pipes and plastic-coated pipes are considered. Polyethylene and epoxy composites are among the materials discussed. Gas-main upgrading projects that replaced old pipes with plastic ones are briefly cited. (This updated bibliography contains 128 citations, 51 of which are new entries to the previous edition.)

0330 Properties and Composition

32181 (PB-90-187972/XAB) **New directions for the catalytic conversion of methane. Annual report, January-December 1989.** Lunsford, J.H. Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. Jan 1990. 26p. Available from NTIS, PC A03/MF A01.

See also PB-89-161467.

Melts prepared from lithium carbonate and talc are effective catalysts for the oxidative dimerization of methane to ethane, with the subsequent conversion of ethane to ethylene (C2 compounds). With 20 g of Li_2CO_3 in a reactor containing alumina rings at 850 C and a CH_4:O_2 ratio of ca. 2 a conversion of 18% and a C_2 selectivity of 36% were observed at steady state. When the reaction was carried out in the presence of talc rings, part of the talc entered the Li_2CO_3, and the conversion and selectivity increased to 43% and 40%, respectively. The positive results observed with talc are believed to result from the combined effects of the MgO, SiO_2 and perhaps iron impurities, as well as the pitted talc rings.

32182 (PB-90-501503/XAB) **Analyses of natural gases, 1917-1989. Data file.** Hamak, J.; Miller, R.; Cupell, L.; Armstrong, G. Bureau of Mines, Amarillo, TX (USA). Helium Field Operations. 31 Dec 1989. mag ta Available from NTISCP T02.

Supersedes PB-89-158661. Source tape is in the ASCII character set. This restricts preparation to 9 track, one-half inch tape only. Identify recording mode by specifying density only. For price at 6250 bpi density, call NTIS Computer Products.

The tape contains routine analyses and related source data for 15015 natural gas samples. These samples were collected as a part of a continuous survey of the Free World for occurrences of helium. The survey has been conducted in the United States by

the Bureau of Mines (USBM) since 1917. In late 1965, the study was expanded to include foreign gas fields. Samples released for publication have been published in a series of USBM bulletins and information circulars. The tape contains samples received through December 31, 1989 that were released for publication. There is one record on the tape for each sample analysis. The tape does not contain a label, standard or non-standard. The tape is a nine-track, 1600 BPI, odd parity, ASCII tape. Each record contains 365 characters. The records are blocked 1 (one) per block.

0340 Combustion

32183 (PB–90-162165/XAB) **Pulsating burners - controlling mechanisms and performance. Annual report, January 1-December 31, 1988.** Zinn, B.T.; Daniel, B.R.; Jagoda, J.I. Georgia Inst. of Tech., Atlanta, GA (USA). School of Aerospace Engineering. Jan 1989. 43p. Available from NTIS, PC A03/MF A01.

See also PB–89-129175.

The report describes the results of an ongoing investigation of the physical and chemical processes which control the operation of gas fired, valved pulse combustors. Results of flow visualization experiments were compared with LDV measurements in the mixing chamber. They show that the flow field is dominated by the entry of the air jet. A large, axial recirculation zone occupies most of the mixing chamber during the combustion phase of the cycle, and the flow is extremely turbulent. Finally, backflow from the tailpipe penetrates several inches into the combustion chamber and it does not reach the combustion region. The admittance of various components which make up the pulse combustor were measured using an impedance tube technique. The real and imaginary parts of the admittances of the fuel valve, the air valve and the mixing chamber fitted with the fuel and air valves were determined over a range of frequencies and for a range of air valve openings. A linear model of the air valve was developed and used to calculate the instantaneous damping by the valve during the cycle. These calculated results are in good qualitative agreement with experimental observations. In addition, the model predicts the times required to open and close the air valve as a function of frequency.

04 OIL SHALES AND TAR SANDS

0403 Drilling, Fracturing, and Mining

32184 (SAND–90-0464C) **Rock motion simulation and prediction of porosity distribution for a two-void-level retort.** Preece, D.S. Sandia National Labs., Albuquerque, NM (USA). [1990]. 14p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC04-76DP00789. (CONF-9005173–1: 23. oil shale symposium, Golden, CO (USA), May 1990). Order Number DE90010825. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The computer program DMC (Distinct Motion Code) was developed in 1988 and 1989 to predict the motion of rock following a conventional blast. The ability to predict the rock motion associated with oil shale retort blasting, along with the induced porosity distribution, has been a driving force behind the development of DMC. Earlier this year DMC was used to simulate the rock motion associated with the rubblization of Occidental Oil Shale's Retort Number 8 which was a three-void-level retort processed in 1982. This paper discusses the algorithm developed to compute the porosity distribution of the muck after rock motion. It also contains a simulation of a two-void-level retort rubblization plan proposed by Ricketts, 1989. DMC is used to model the rock motion associated with the blasting and to obtain a final porosity distribution. Some improvement in the porosity distribution is seen over that observed in the three-void-level simulation. Thus, it may be that the two-void-level approach is not only more efficient to mine, but may also produce a more uniform rubble bed. 8 refs., 12 figs.

0404 Oil Production, Recovery, and Refining

32185 (DOE/MC/11076–2807) **Western states enhanced oil shale recovery program: Shale oil production facilities conceptual design studies report.** Western Research Inst., Laramie, WY (USA). Aug 1989. 205p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-86MC11076. Order Number DE90000467. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

This report analyzes the economics of producing syncrude from oil shale combining underground and surface processing using Occidental's Modified-In-Situ (MIS) technology and Lawrence Livermore National Laboratory's (LLNL) Hot Recycled Solids (HRS) retort. These retorts form the basic technology employed for oil extraction from oil shale in this study. Results are presented for both Commercial and Pre-commercial programs. Also analyzed are Pre-commercialization cost of Demonstration and Pilot programs which will confirm the HRS and MIS concepts and their mechanical designs. These programs will provide experience with the circulating Fluidized Bed Combustor (CFBC), the MIS retort, the HRS retort and establish environmental control parameters. Four cases are considered: commercial size plant, demonstration size plant, demonstration size plant minimum CFBC, and a pilot size plant. Budget cost estimates and schedules are determined. Process flow schemes and basic heat and material balances are determined for the HRS system. Results consist of summaries of major equipment sizes, capital cost estimates, operating cost estimates and economic analyses. 35 figs., 35 tabs.

32186 (UCID–16986-89-2/3/4) **Oil shale quarterly report, April–December 1989.** Cena, R. Lawrence Livermore National Lab., CA (USA). 16 Apr 1990. 28p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-7405-ENG-48. Order Number DE90010282. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Research on oil shales is reported. Programs discussed include: coke formation on the burnt shale present in a solid-cycle fluidized bed retort; coking of flash-pyrolyzed shale oil vapors in a down stream packed-bed reactor; pilot plant development; and short term carbonate decomposition in green river oil shale. 17 refs., 21 figs., 7 tabs. (CBS)

0405 Properties and Composition

Refer also to citation(s) 32165, 32166, 32186

32187 **Derivative spectrophotometry of metalloporphyrins from shale.** Freeman, D.H. (Univ. of Maryland, College Park (USA)). 31 of Division of Geochemistry, Inc. 197th ACS National Meeting. American Chemical Society, Washington, DC (US) (1989). DOE Contract FG05-85ER13308. (CONF-8904132–: American Chemical Society Division of Geochemistry, Dallas, TX (USA), 9-14 Apr 1989).

This research is part of a continuing effort to develop improved methods for the isolation and characterization of geoporphyrins. This talk will report problems solved and progress being made toward the determination of geoporphyrins in shale extract. PC controlled diode array spectrophotometry will be discussed as it offers greatly improved speed. The analytical results show that improved precision and sensitivity are obtained by using derivative methods for data enhancement. Evidence for, and measures against interparticle heterogeneity were found. Ferguson's criteria (1962) for extraction testing and for the merit of using macroporous adsorbents for liquid chromatography were verified.

32188 **Ammonia evolution from western and eastern oil shales.** Myongsook S. Oh (Lawrence Livermore National Lab., CA (USA)); Crawford, R.W.; Foster, K.G.; Alcaraz, A. 44 of Division of Geochemistry, Inc. 197th ACS National Meeting. American Chemical Society, Washington, DC (US) (1989). (CONF-8904132–: American Chemical Society Division of Geochemistry, Dallas, TX (USA), 9-14 Apr 1989).

Real time evolution of ammonia during pyrolysis of oil shale was measured by means of a mass spectrometer using chemical ionization. The authors studied two Green River Formation oil shales and one New Albany oil shale. They employed steam as a retorting gas to measure the total amount of ammonia generated and to study the extent of ammonia decomposition reactions on oil shale particle surfaces. They derived kinetics of ammonia evolution from organic and inorganic sources in oil shales and compared them with the evolution kinetics of other pyrolysis gases.

32189 Study of eastern and western oil shale minerals activity for hydrodesulfurization (HDS) and hydrodenitrogenation (HDN) reactions. Shamsi, A. (Morgantown Energy Technology Center, WV (USA)). 40 of Division of Geochemistry, Inc. 197th ACS National Meeting. American Chemical Society, Washington, DC (US) (1989). (CONF-8904132–: American Chemical Society Division of Geochemistry, Dallas, TX (USA), 9-14 Apr 1989).

Studies have been conducted at METC (Morgantown Energy Technology Center) to provide a fundamental understanding of heterogeneous catalytic behavior of minerals in oil shale pyrolysis. HDS and HDN reactions of sulfur and nitrogen model compounds over eastern and western oil shale minerals have been studied. The results indicate that shale minerals are active for HDS reactions that convert thiophene to hydrocarbons and hydrogen sulfide, but they are not as active for the HDN reactions that convert nitrogen-containing heterocyclic compounds to ammonia and hydrocarbons. The major products analyzed from HDN reaction of piperidine over Colorado low temperature ashed (LTA) shales were pyridine, nitriles, and hydrocarbons, and no significant reactions were observed for pyridine. The products obtained from reaction of thiophene over eastern LTA shales were C_1 to C_4 hydrocarbons; whereas, with western LTA shale higher hydrocarbons such as unsaturated cyclic compounds of C_5 and C, plus a wide variety of alkyl-benzenes were detected. The HDS reaction of thiophene over dolomite, siderite, illite, calcite, and a mixture of these minerals was studied. The HDS and HDN activity of combusted spent shales will be discussed.

0408 Economic, Industrial, and Business Aspects

Refer also to citation(s) 32185, 32190

0409 Waste Management

Refer also to citation(s) 32081

32190 (EGG-M–88503) **History and some potentials of oil shale cement.** Knutson, C.F.; Smith, R.P.; Russell, B.F. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 34p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC07-76ID01570. (CONF-8904193–4: 22. annual oil shale symposium, Golden, CO (USA), 19-20 Apr 1989). Order Number DE90010918. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The utilization of oil shale as a cement component is reviewed. Historical aspects and co-combustion with coal are discussed. 82 refs., 10 figs., 1 tab. (CBS)

0440 Combustion

Refer also to citation(s) 32190

05 NUCLEAR FUELS

0501 Reserves, Exploration, and Mining

32191 (CNIC–00257) **Digital image integration technique of multiple geoscience information system and its application.** Liu Dechang (Ministry of Nuclear Industry, Beijing, BJ (China). Beijing Inst. of Uranium Geology); Zou Jingke; Sun Maorong; Wang Guojuan. China Nuclear Information Centre, Beijing, BJ (China). 1988. 11p. (In Chinese). (BUGRI–0005). Order Number DE90627893. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

By using the computer integration technique, the multiple geoscience information such as geological, remote sensing, hydrogeological, geophysical and geochemical information is comprehensively processed. The technique consists of the data input, registration, interpolation, and the enhancement, decomposition, abstraction, classification, overlay and combination process procedures. This technique has been tested on six promising areas and one testing area where the geological environment had been known. In the testing area, the distribution pattern of U, Th and K as well as their geological significance were analysed. On the basis of compositing and abstracting the prospecting criteria, the target areas were preliminarily selected. The information classification technique was used for the general evaluation of uranium resource. Finally, on the tested results a multiple geological information image system for uranium resource evaluation has been established.

32192 (NAGRA-NTB–88-30) **Genesis, alteration and recent waterbearing structures of the Krunkelbach (Menzenschwand, Southern Black Forest) uranium deposit.** Hofmann, B. (Mineralogisch-petrographisches Inst., Univ. Bern (Switzerland)). Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Feb 1989. 215p. (In German). Available from Nagra, CH-5401 Baden, Switzerland.

In the Krunkelbach uranium pilot-mine near Menzenschwand in the Black Forest massif, U-ore veins, variably altered granite, waterbearing fractures and groundwater samples have been investigated mineralogically and geochemically and compared with rocks and groundwaters of the region. These investigations were performed in order to clarify the genesis and history of the deposit and to test the suitability of this natural accumulation of radioisotopes for the study of natural analogues of potential mobilization/retardation processes in radioactive waste repositories. (author) 52 figs., 239 refs.

0504 Feed Processing

32193 (CNIC–00112) **The application of expandable polystyrene pellets as filter media to controlled filter in a uranium mill.** Mao Ruiguo (Ministry of Nuclear Industry, Beijing, BJ (China). Research Inst. of Uranium Ore Processing); Liu Mingde; Li Chunhua. China Nuclear Information Centre, Beijing, BJ (China). Nov 1987. 13p. (In Chinese). (BRIUOP–0005). Order Number DE90627831. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Expandable polystyrene pellets as filter media are used for controlled filter of uranium ore processing. Results from bench scale tests, pilot plant tests and full scale tests are satisfactory. The filter used in the full scale tests is 4 m in diameter, and the capacity is from 75 to 100 m^3 per hour. The solid content in the pregnant solution which overflowing the first thichener contains about 250 ppm of suspended solid can be reduced to 5 ≈ 10 ppm. The filter bed is backflushed with the feed liquors and the backflush returns to the countercurrent decantation circuit. The entrainment loss of the organic phase in the raffinate from solvnet extraction can be decreased by about 60% with treating the filtrated solution.

0505 Uranium Enrichment

Refer also to citation(s) 33847

0507 Fuels Production and Properties

Refer also to citation(s) 32572, 32603, 32779, 32834

32194 (GAO/RCED–90-54) **Nuclear materials: Information on DOE's replacement tritium facility.** General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div. Dec 1989. 8p. Available from US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877 (USA).

This paper presents a review of DOE plans to complete and operate a replacement for the tritium loading facility at the Savannah River Site in Aiken, South Carolina. This loading facility processes important components used in nuclear weapons. GAO found that the new facility should substantially improve tritium operations, but that costs have increased by 20 percent from $120 million to $144 million, although the largest increases have been in the start-up costs, which have risen by more than 350 percent - from a fiscal year 1986 estimate of $17 million to a fiscal year 1989 estimate of $62 million.

0508 Spent Fuels Reprocessing

Refer also to citation(s) 32257, 33127

32195 (CNIC–00170) **The extraction of Eu^{+3} from simulated high level liquid waste of nuclear power reactor reprocessing**

by centrifugal extractors. Zheng Hualing (Beijing Inst. of Nuclear Engineering, BJ (China)); Zhou Shunli; Chen Shuming; Jiao Rongzhou; Wang Shouzhong; Fan Shiguo; Liu Bingren. China Nuclear Information Centre, Beijing, BJ (China). Feb 1988. 6p. (In Chinese). (BINE–0007). Order Number DE90627832. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The mass transfer dynamics of extracting Eu from simulated high level liquid waste (HLLW) solution and HNO_3 aqueous solution with 30% TRPO-OK have been investigated by ϕ 10 mm centrifugal extractors. Efficiency of the mass transfer have been determined. It is more than 98% during one minute holdup time. All data prove that mass transfer speed is enough rapid, stage efficiency is high. In tests of extracting Eu from simulated HLLW solution by multi-stage extractors, extraction efficiency of Eu are>99.99% (6 stages, 0.58 mol/L HNO_3 feed) and 99.83% (12 stages, 2.5 mol/L HNO_3 feed) respectively. The concept flow designed has been proved.

32196 (FRCEA-TH–238) **Study of axial mixing phenomena in pulse columns equipped with crown-disk packing.** Buratti, M.F. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France); CEA Etablissement de la Vallee du Rhone, 30 - Bagnols-sur-Ceze (France); Institut National Polytechnique, 54 - Nancy (France). Dec 1988. 241p. (In French). Order Number DE90792918. Available from NTIS (US Sales Only), PC A11/MF A01.

For optimization of pulsed columns which will be used in reprocessing plants, axial mixing, essentially due to non-ideal flow and which contributes to efficiency by reducing mass transfer potential, is studied. Dispersion coefficients are measured experimentally one-phase and two-phase flow for the continuous and dispersed phases. Axial dispersion coefficients are obtained for various operating conditions and varions configurations. During extraction dispersion coefficients for the continuous phase can be calculation with a good approximation. To reduce axial mixing, it is sufficient to increase phase rate or reduce packing spacing or decrease pulse frequency or amplitude. However, it is better to operate with a low amplitude and a high pulse frequency for a same circulation.

0509 Transport, Handling, and Storage

Refer also to citation(s) 32331

32197 (CONF-900563–1) **A high-sensitivity, position-sensitive fission chamber for subcriticality measurement of spent fuel.** Williams, J.A. (Oak Ridge National Lab., TN (USA)); Mihlaczo, J.T.; Ricker, C.W.; Glesius, F.L.; Kniss, T.A. Oak Ridge National Lab., TN (USA). [1990]. 7p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC05-84OR21400. From 7. symposium on radiation measurements and applications; Ann Arbor, MI (USA); 21-24 May 1990. Order Number DE90010440. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A high-sensitivity multisection fission counter has been developed by Reuter Stokes, Inc., under the Small Business Innovation Research Program of the US Department of Energy. This counter, designated the high-sensitivity position-sensitive fission counter (HSPSFC), was developed for subcriticality measurements by the ^{252}Cf-source-driven neutron noise analysis method–a method that requires two neutron detection channels. Performance specifications for the counter were provided by ORNL for measurements on spent LWR fuel configurations in which multiplication factors (k-values) could be as low as 0.85. A 3 x 3 array of 2-in. dia multisection fission counters 8 ft in length will fit storage rack positions occupied by LWR fuel elements. Each counter consists of eight sensitive sections containing a total of ~23 g of ^{235}U. Transmission-line technology is used to minimize capacitances and thus provides broad bandwidths. Each event in the fission counter produces two current pulses propagating in opposite directions on the transmission line. The differences between arrival times of the pulses at the ends of a multisection fission counter determine the positions of the fission events. Tests on two fission counters indicate that each counter has a sensitivity of 16 cps/nv_{th} and a position sensitivity with 1-ft resolution. 7 refs.

32198 (PNL–7167) **Criticality experiments with neutron flux traps containing voids.** Bierman, S.R. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 47p. Sponsored by U.S. DOE Defense Programs; U.S. DOE Radioactive Waste Management. DOE Contract AC06-76RL01830. (TTC–0969). Order Number DE90010319. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A research program was initiated for the US Department of Energy (DOE) by the Sandia National Laboratory Transportation Systems Development Department in 1982 to provide benchmark type experimental criticality data in support of the design and safe operations of nuclear fuel transportation systems. The overall objective of the program is to identify and provide the experimental data needed to form a consistent, firm, and complete data base for verifying calculational models used in the criticality analyses of nuclear transport and related systems. 2 refs., 6 figs., 7 tabs.

0520 Waste Management

Refer also to citation(s) 32252, 32550, 32614, 32706, 32728, 32810, 33263, 33264, 33265, 33266, 33267, 33268, 33269, 33270, 33271, 33272, 33273, 33274, 33275

32199 (BNL–43691) **Encapsulation of mixed radioactive and hazardous waste contaminated incinerator ash in modified sulfur cement.** Kalb, P.D.; Heiser, J.H. III; Colombo, P. Brookhaven National Lab., Upton, NY (USA). [1990]. 8p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC02-76CH00016. (CONF-9005123–2: 9. annual international symposium on the incineration of radioactive, hazardous, mixed and medical wastes: incineration conference '90, San Diego, CA (USA), 14-18 May 1990). Order Number DE90010647. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Some of the process waste streams incinerated at various Department of Energy (DOE) facilities contain traces of both low-level radioactive (LLW) and hazardous constituents, thus yielding ash residues that are classified as mixed waste. Work is currently being performed at Brookhaven National Laboratory (BNL) to develop new and innovative materials for encapsulation of DOE mixed wastes including incinerator ash. One such material under investigation is modified sulfur cement, a thermoplastic developed by the US Bureau of Mines. Monolithic waste forms containing as much as 55 wt % incinerator fly ash from Idaho national Engineering Laboratory (INEL) have been formulated with modified sulfur cement, whereas maximum waste loading for this waste in hydraulic cement is 16 wt %. Compressive strength of these waste forms exceeded 27.6 MPa. Wet chemical and solid phase waste characterization analyses performed on this fly ash revealed high concentrations of soluble metal salts including Pb and Cd, identified by the Environmental Protection Agency (EPA) as toxic metals. Leach testing of the ash according to the EPA Toxicity Characteristic Leaching Procedure (TCLP) resulted in concentrations of Pb and Cd above allowable limits. Encapsulation of INEL fly ash in modified sulfur cement with a small quantity of sodium sulfide added to enhance retention of soluble metal salts reduced TCLP leachate concentrations of Pb and Cd well below EPA concentration criteria for delisting as a toxic hazardous waste. 12 refs., 4 figs., 2 tabs.

32200 (BNL-NUREG–44506) **Decontamination impacts on solidification and waste disposal.** Kempf, C.R.; Soo, P. Brookhaven National Lab., Upton, NY (USA). [1988]. 25p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (CONF-8810155–50: 16. water reactor safety information meeting, Gaithersburg, MD (USA), 24-27 Oct 1988). Order Number DE90010643. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Research to determine chemical and physical conditions which could lead to thermal excursions, gas generation, and/or general degradation of decontamination-reagent-loaded resins has shown that IRN-78, IONAC A-365, and IRN-77 organic ion exchange resin moisture contents vary significantly depending on the counter ion "loading." The extent/vigor of the reaction is very highly dependent on the degree of dewatering of the resins and on the method of solution addition. The heat generation may be due, in part, to the heat of neutralization. In studies of the long-term compatibility effects of decontamination waste resins in contact with waste package container materials in the presence of decontamination reagents,

radiolysis products and gamma irradiation, it has been found that the corrosion of carbon steel and austenitic stainless steel in mixed bed resins is enhanced by gamma irradiation. However, cracking in high density polyethylene is essentially eliminated because of the rapid removal of oxygen from the environment by gamma-induced oxidation of the large resin mass. 13 refs., 10 figs., 3 tabs.

32201 (CEA-TH–260) **Effect of environmental materials on R7T7 nuclear waste glass alteration. Clay effect.** Godon, N. CEA Etablissement de la Vallee du Rhone, 30 - Bagnols-sur-Ceze (France); CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France); CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France); Orleans Univ., 45 (France). 1988. 344p. (In French). Order Number DE90792920. Available from NTIS (US Sales Only), PC A15/MF A01.

The alteration of R7T7 glass was investigated in contact with different environmental materials, with a special focus on clay effect. In a first part, experiments were conducted at 90°C with eleven material including smectites, bentonites, illites, granic and sand. Kinetics studies, lasting up to 364 days, were performed on four selected materials. These studies were completed by several integral experiments simulating a geological repository. Almost all the selected clay appeared to enhance glass corrosion. The main role of clay seems to prevent or delay obtainment of saturation condition in which glass corrosion is extremely reduced. The duration of this clay effect seems directly related to the clay mass to glass surface ratio. However, an actived bentonite was found not to enhance glass corrosion, and let the way open for a backfilling without any detrimental effect on glass.

32202 (CONF-900676–4) **Multimedia assessment of health risks for the Weldon Spring site remedial action project.** Haroun, L.A.; MacDonell, M.M.; Peterson, J.M.; Fingleton, D.J. Argonne National Lab., IL (USA). [1990]. 18p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From 83. annual meeting and exhibition of the Air and Waste Management Association; Pittsburgh, PA (USA); 24-29 Jun 1990. Order Number DE90011116. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The US Department of Energy (DOE), under its Surplus Facilities Management Program (SFMP), is responsible for cleanup activities at the Weldon Spring site, Weldon Spring, Missouri. The site consists of two noncontiguous areas: the chemical plant area, which includes four raffinate pits, and the quarry. The Weldon Spring site became radioactively and chemically contaminated as a result of processing and disposal activities that took place from the 1940s through the 1960s. The US Department of the Army used the Weldon Spring site to produce dinitrotoluene (DNT) and trinitrotoluene (TNT) explosives from 1941 to 1946. The US Atomic Energy Commission (AEC, predecessor of the DOE) used the site to process uranium and thorium ore concentrates from 1957 to 1966. The quarry was used by the Army and the AEC for waste disposal beginning in the early 1940s; it was last used for disposal in 1969. Wastes placed in the quarry include TNT and DNT residues and radioactively contaminated materials. A summary of disposal activities at the quarry is presented. As part of the environmental compliance process at the Weldon Spring site, a baseline risk evaluation (BRE) was prepared to assess the potential risks associated with contamination present at the quarry. 13 refs., 2 figs., 6 tabs.

32203 (CONF-9006139–1) **Multicomponent ion-exchange equilibria in chabazite zeolite.** Robinson, S.M.; Arnold, W.D.; Byers, C.H. Oak Ridge National Lab., TN (USA). [1990]. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From ACS symposium on emerging technologies for hazardous waste treatment; Atlantic City, NJ (USA); 4-7 Jun 1990. Order Number DE90010703. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Efficient design ion-exchange columns, using Ionsiv IE-96 chabazite zeolite, for the decontamination of process wastewater that contains ppB levels of Sr-90 and Cs-137 requires a detailed study of binary and multicomponent ion-exchange equilibria. Experimental isotherms were acquired for Ca–Na, Mg–Na, Sr–Na, Cs–Na, Sr–Cs–Na, Ca–Mg–Na, Sr–Ca–Mg–Na, Cs–Ca–Mg–Na, and Sr–Cs–Ca–Mg–Na comparing batch and column experimental approaches. Binary isotherms obtained by the batch technique were most successfully fitted with a modification of the Dubinin-Polyani equilibrium model. Prediction of the multicomponent equilibria from binary data will require more sophisticated modeling. 15 refs., 5 figs., 3 tabs.

32204 (DOE/HWP–99) **Proceedings of the US Department of Energy Office of Environmental Restoration and Waste Management waste reduction workshop 4.** Oak Ridge National Lab., TN (USA). Hazwrap Support Contractor Office. Mar 1990. 294p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. DOE Contract AC05-84OR21400. (CONF-9002121–: 4. U.S. Department of Energy Office of Environmental Restoration and Waste Management waste reduction workshop, Tampa, FL (USA), 6-7 Feb 1990). Order Number DE90010826. Available from NTIS, PC A13/MF A01; OSTI; INIS; GPO Dep.

The fourth of a series of waste minimization/reduction workshops was held at the Sheridan Grand Hotel in Tampa, Florida, on February 6–7, 1990. The workshops are held under the auspices of the Department of Energy's (DOE's) Office of Environmental Restoration and Waste Management. This workshop provided a forum for waste minimization/reduction planning, including waste minimization assessments. The workshops assist DOE waste-generating sites in implementing waste minimization/reduction programs, plans, and activities, thus providing for optimal waste reduction within the DOE complex. All wastes are considered within this discipline: liquid, solid, and airborne, within the categories of high-level, transuranic (TRU), low-level (LLW), hazardous, and mixed. Topics of discussion within workshops encompassed a wide range of subjects. Subjects included any method or technical activity from waste generation to disposal, such as process design or improvement, substitution of materials, waste segregation and recycling/reuse, waste treatment and processing, and administrative controls (procurement and waste awareness training). Consideration was also given to activities for remedial action and for decontamination and disposal. 1 tab.

32205 (DOE/IG–0284) **Management information systems for environmental compliance activities.** USDOE Office of Inspector General, Washington, DC (USA). Capital Regional Office. 23 Apr 1990. 20p. Sponsored by U.S. DOE Office of Inspector General. Available from OSTI.

Report to The Secretary.

The Department of Energy (DOE) is subject to Federal and state laws designed to protect against threats to public health and the environment. The purpose of this audit was to determine whether the Department had developed adequate information systems for tracking and reporting on the status of its compliance with these laws. Systems used for prioritizing and budgeting for environmental activities are being addressed in a separate review.

32206 (DOE/NBB–0071-Vol.1) **Monitored retrievable storage facility site screening and evaluation report: Volume 1.** Golder Associates, Inc., Bellevue, WA (USA). May 1985. 389p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-84RL10436. Order Number DE90010696. Available from NTIS, PC A17/MF A01; OSTI; INIS.

The Nuclear Waste Policy Act of 1982 directs the Department of Energy to "complete a detailed study of the need for and feasibility of, and to submit to the Congress a proposal for, the construction of one or more monitored retrievable storage facilities for high level radioactive waste and spent nuclear fuel." The Act directs that the proposal includes site specific designs. Further, the proposal is to include, "for the first such facility, at least three alternative sites and at least five alternative combinations of such proposed site and facility designs..." as well as a recommendation of "the combination among the alternatives that the Secretary deems preferable." An MRS Site Screening Task Force has been formed to help identify and evaluated potential MRS facility sites within a preferred region and with the application of a siting process and criteria developed by the DOE. The activities of the task force presented in this report includes: site screening (Sections 3, 4, and 5), the MRS facilities which are to be sited are described; the criteria, process and outcome of the screening process is presented; and descriptions of the candidate MRS facility sites are given, and site evaluations (Sections 6 through 9) where the rational for the site

evaluations are presented, along with each evaluation and findings of the Task Force.

32207 (DOE/NBB–0071-Vol.2) **Monitored retrievable storage facility site screening and evaluation report: Volume 2.** Golder Associates, Inc., Bellevue, WA (USA). May 1985. 386p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-84RL10436. Order Number DE90010697. Available from NTIS, PC A17/MF A01; OSTI; INIS.

The Nuclear Waste Policy Act of 1982 directs the Department of Energy to "complete a detailed study of the need for and feasibility of, and to submit to the Congress a proposal for, the construction of one or more monitored retrievable storage facilities for high level radioactive waste and spent nuclear fuel." The Act directs that the proposal includes site specific designs. Further, the proposal is to include, "for the first such facility, at least three alternative sites and at least five alternative combinations of such proposed sites and facility designs···" as well as a recommendation of "the combination among the alternatives that the Secretary deems preferable." An MRS Site Screening Task Force has been formed to help identify and evaluate potential MRS facility sites within a preferred region and with the application of a siting process and criteria developed by the DOE. The activities of the Task Force presented in this report include: site evaluations (sections 10 through 12) where the rationale for the site evaluations are presented, along with each evaluation and findings of the Task Force. This in Volume 2 of a three volume document.

32208 (DOE/NBB–0071-Vol.3) **Monitored Retrievable Storage facility site screening and evaluation report: Volume 3.** Golder Associates, Inc., Bellevue, WA (USA). May 1985. 272p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-84RL10436. Order Number DE90010698. Available from NTIS, PC A12/MF A01; OSTI; INIS.

The Nuclear Waste Policy Act of 1982 directs the Department of Energy to "complete a detailed study of the need for and feasibility of, and to submit to the Congress a proposal for, the construction of one or more monitored retrievable storage facilities for high level radioactive waste and spent nuclear fuel." The Act directs that the proposal includes site specific designs. Further, the proposal is to include, "for the first such facility, at least three alternative sites and at least five alternative combinations of such proposed sites and facility designs ···" as well as a recommendation of "the combination among the alternatives that the Secretary deems preferable." An MRS Site Screening Task Force has been formed to help identify and evaluate potential MRS facility sites within a preferred region and with the application of a siting process and criteria developed by the DOE. The activities of the Task Force presented in this report, all site evaluations (sections 13 through 16) where the rationale for the site evaluations are presented, along with each evaluation and findings of the Task Force. This is Volume 3 of a three volume document. References are also included in this volume.

32209 (DOE/RL–88-04-Rev.2) **183-H solar evaporation basins closure/post-closure plan: Revision 2.** USDOE Richland Operations Office, WA (USA). [1990]. 708p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90011105. Available from NTIS, PC A99/MF A01 - OSTI; GPO Dep.

The US Department of Energy-Richland Operations Office (DOE-RL) will close the 183-H Solar Evaporation Basins (183-H Basins) in accordance with the US Environmental Protection Agency (EPA), Resource Conservation and Recovery Act (RCRA) OF 1976. While preparing this document, it has been acknowledged that this RCRA closure site is located within an identified Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (CERCLA 1980) unit; 100-Areas site. The proposed closure activities (e.g., soil sampling, groundwater monitoring, waste removal, and landfill cover design and installation) will be conducted in conjunction with the future RCRA past practices remediation. This document is organized into four chapters and 13 appendices: general closure requirements (chapter 1), closure requirements for landfills (chapter 2), post-closure requirements (chapter 3), references (chapter 4), and appendices (A through M). 66 figs., 43 tabs.

32210 (DOE/RL–89-10) **Environmental restoration and waste management site-specific plan for the Richland Operations Office: Detailed information.** USDOE Richland Operations Office, WA (USA). Dec 1989. 205p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE90010860. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

This plan provides a summary of environmental and waste management activities planned at the Hanford Site. Waste management operations include those activities associated with the minimization, treatment, storage, or disposal of all radioactive, hazardous, or mixed wastes generated as a result of ongoing operations at active facilities. Environmental restoration is concerned with the assessment and cleanup of facilities and sites that are no longer part of active operations. Environmental restoration includes remedial actions and decontamination and decommissioning. Corrective activities are those projects and activities required to bring active and standby facilities into compliance with environmental regulatory requirements and internal DOE requirements for air, surface water, and solid waste. 28 figs., 12 tabs.

32211 (DOE/RL–89-26) **Hanford Waste Vitrification Plant Clean Air Act permit application.** USDOE Richland Operations Office, WA (USA). Apr 1990. 170p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE90010317. Available from NTIS, PC A08/MF A01; OSTI; INIS; GPO Dep.

This document briefly describes the Hanford Site and provides a general overview of the Hanford Waste Vitrification Plant (HWVP). Other topics include sources of emissions, facility operating parameters, facility emissions, pollutant and radionuclide control technology and air quality. The HWVP will convert mixed wastes (high-activity radioactive and hazardous liquid wastes) to a solid vitrified form (borosilicate glass) for disposal. Mixed wastes pretreated in the Hanford Site B Plant will be pumped into double-shell tanks in the 200 East Area for interim storage. This pretreated mixed waste will be batch transferred from interim storage to the HWVP facility, where the waste will be concentrated by evaporation, treated with chemicals, and mixed with glass-forming materials. The mixture will then be continuously fed into an electrically heated glass melter. The molten glass will be poured into canisters that will be cooled, sealed, decontaminated, and stored until the vitrified product can be transferred to a geologic repository. 25 refs., 18 figs., 32 tabs.

32212 (DOE/SR-WM–90-1) **Savannah River Waste Management Program Plan, FY 1990.** USDOE Savannah River Operations Office, Aiken, SC (USA). Dec 1989. 169p. Sponsored by U.S. DOE Defense Programs. Order Number DE90010289. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

This document provides the Waste Management Program Plan. The primary purpose of the plan is to provide an annual report of how waste management's operations are conducted, what facilities are being used to manage wastes, what forces are acting to change current waste management systems, and what plans are in store for the coming fiscal year. In addition, this document projects activities for several years beyond the coming fiscal year in order to adequately plan for safe handling, storage, and disposal of radioactive wastes generated at Savannah River and for developing technology for improved management of wastes. A revised plan will be issued at the beginning of each fiscal year. In this document, work descriptions and milestone schedules are current as of September 1989. Budgets are based on available information as of September 1989. 60 figs., 31 tabs.

32213 (DP-MS–89-78) **WIPP/SRL [Waste Isolation Pilot Plant/Savannah River Laboratory] in-situ tests: Compositional correlations of MIIT [Materials Interface Interactions Test] waste glasses.** Ramsey, W.G. (Clemson Univ., SC (USA). Dept. of Ceramic Engineering); Wicks, G.G. Savannah River Lab., Aiken, SC (USA). [1989]. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-890488–14: 4. international symposium on ceramics in nuclear waste management, Indianapolis, IN (USA), 23-27 Apr 1989). Order Number DE90011241. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Materials Interface Interactions Test (MIIT) is the only in-situ program involving the burial of simulated high-level waste forms

operating in the United States. Fifteen glass and waste form compositions and their proposed package materials, supplied by 7 countries, are interred in salt at the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico. A joint effort between Sandia National Laboratories and Savannah River Laboratory, MIIT is the largest and most internationally cooperative in-situ venture yet undertaken. The objective of the current study is to document the waste form compositions used in the MIIT program and then to examine compositional correlations based on structural considerations, bonding energies, and surface layer formation. These correlations show important similarities between the many different waste glass compositions studied world wide and suggest that these glasses would be expected to perform well and in a similar manner. The compositional correlations define a 'commonality' between all MIIT waste forms and assist in furthering our understanding on the performance of high-level waste glass. 16 refs., 5 figs.

32214 (DPST–82-492) **Special Wasteform Lysimeter Program wasteform characteristics.** Mersman, K.E. Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab. 21 Apr 1982. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90011302. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Special Wasteform Lysimeter Program was begun on April 2, 1981 with the approval of Test Authorization No. 2-995. The program is wholly funded by the National Low-Level Waste (LLW) Program with the of determining how typical power reactor wasteforms perform in a humid burial site. The specific interest in the program here at the Savannah River Plant (SRP) is to evaluate matrices for leach resistance of typical incinerator ash and other LLW with the purpose of improving burial practices. During late February and early March 1982, ten special wasteform lysimeters were loaded with typical power reactor wasteforms. These wasteforms were obtained from two commercial sites. The solidification agents used to immobilize the waste were concrete and a polymer marketed by Dow Chemical. Both a 25 wt % Na_2SO_4 solution and a 12 wt % boric acid solution were solidified. Typical radionuclides present in the waste include Co-60, Cs-137, Cs-134, and Mn-54. 3 refs., 2 figs., 7 tabs.

32215 (EGG-M–89251) **Soil gas surveying at low-level radioactive waste sites.** Crockett, A.B.; Moor, K.S.; Hull, L.C. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 21p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-8908227–1: DOE low-level waste management conference, Denver, CO (USA), 21 Aug 1989). Order Number DE90010904. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Soil gas sampling is a useful screening technique for determining whether volatile organic compounds are present at low-level radioactive waste burial sites. The technique was used at several DOE sites during the DOE Environmental Survey to determine the presence and extent of volatile organic compound contamination. The advantages of the soil gas sampling are that near real time data can be obtained, no excavation is required, safety concerns are relatively minor, costs are relatively low, and large amounts of data can be obtained rapidly on the contaminants that may pose the greatest threat to groundwater resources. The disadvantages are that the data are difficult to interpret and relate to soil concentrations and environmental standards. This paper discusses the experiences of INEL sampling and analysis personnel, the advantages and disadvantages of the technique, and makes recommendations for improving the sampling and procedures. 11 refs., 8 figs., 3 tabs.

32216 (EGG-M–89464) **Offgas system particulate cleaning test and evaluation for the Process Experimental Pilot Plant.** Ayers, A.L. Jr.; Gale, L.G.; Stermer, D.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 8p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-9005123–3: 9. annual international symposium on the incineration of radioactive, hazardous, mixed and medical wastes: incineration conference '90, San Diego, CA (USA), 14-18 May 1990). Order Number DE90010982. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Process Experimental Pilot Plant (PREPP) incinerates mixed solid waste. The exhaust gas is processed through a wet offgas cleaning system. Rapid loading of the exhaust filters has been a problem and an important contributing factor is the use of a quench solution containing a relatively high concentration of dissolved solids. The dissolved solids are released as a submicron particulate when the quench solution evaporates. A series of tests were performed to better identify the nature of the problem and explore solutions to the problem involving modifications to the quench process. 2 refs., 7 figs.

32217 (EGG-M–90189) **Results of field testing of waste forms using lysimeters.** McConnell, J.W. Jr.; Rogers, R.D. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 15p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. (CONF-9005178–1: 2. annual international seminar on radioactive waste products, Julich (Germany, F.R.), 28 May - 1 jun 1990). Order Number DE90010905. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The TMI-2 EPICOR-II Resin/Liner Low-Level Waste Data Base Development Program is obtaining information on the performance of radioactive waste in a disposal environment. Waste forms fabricated using ion-exchange resins from EPICOR-II prefilters employed in the cleanup of the Three Mile Island (TMI) Nuclear Power Station are being tested to: develop a low-level waste data base, and obtain information on survivability of waste forms in a disposal environment. This paper gives field testing results of those waste forms through FY-1989. The results from the lysimeter experiments are presented and the use of lysimeter data to determine input parameters used in performance assessment is discussed. 7 refs., 11 figs., 2 tabs.

32218 (ERCE-R–89-42) **Public perception and acceptance of the siting of nuclear waste facilities in seven countries.** Numark, N.J. (ERC Environmental and Energy Services Co., Fairfax, VA (USA)); Paige, H.W.; Wonder, E.F. Pacific Northwest Lab., Richland, WA (USA); ERC Environmental and Energy Services Co., Fairfax, VA (USA). Sep 1989. 229p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Order Number DE90010318. Available from NTIS, PC A11/MF A01; OSTI; INIS; GPO Dep.

This report was prepared by ERC Environmental and Energy Services Co. (ERCE) on behalf of the Pacific Northwest Laboratory (PNL) and the US Department of Energy (DOE) between February and August 1989. It updates previous reports prepared by ERCE on public acceptance of waste management activities in foreign countries. The report is intended to serve as an aid in understanding experiences with public acceptance of waste activities in foreign countries, and thereby benefit US efforts with respect to public acceptance based on lessons learned abroad. Seven countries are addressed in the report: Belgium, the Federal Republic of Germany, France, Japan, Sweden, Switzerland, and the United Kingdom. The information provided in this report was obtained both from direct interviews of the responsible waste management officials in the seven countries surveyed and from source documents provided by these individuals.

32219 (GAO/RCED–89-178) **Nuclear waste: Quaterly report as of March 21, 1989.** General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div. Aug 1989. 28p. Available from US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877 (USA).

The Department of Energy plans to award a contract to Bechtel Systems Management, Inc. to manage and operate the federal government's nuclear waste repository. The proposed management and operating contract is likely to substantially affect program operations and costs. This paper reports on a GAO report. A major concern is the degree to which the selected contractor might replace, or possibly duplicate, the efforts now being carried out by DOE's current contractors. It is questionable whether the contract will result in a more efficient and effective program. DOE officials have had to divert their attention from program operations to develop the contract proposal and participate in legal proceedings related to a bid protest. GAO and the DOE inspector general have reported on problems and issues involving DOE's administration of management and operating contracts, including some companies

which participate in the nuclear waste program. Many of the resulting recommendations have yet to be implemented. Implementation of these recommendations could help ensure that the nuclear waste program is operated in a more cost-effective manner.

32220 (GAO/RCED–90-59) **Nuclear waste.** General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div. Dec 1989. 27p. Available from US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877 (USA).

This paper presents a report on DOE's implementation of the Nuclear Waste Policy Act of 1982 discusses changes in waste program contracting patterns that have occurred since December 1987. The Nuclear Waste Policy Amendments Act of 1987 significantly altered DOE's waste program by ending work investigating two sites for a first repository; focusing first repository activities on the Yucca Mountain, Nevada site; and postponing work on a second repository. GAO's analysis shows that the total number of nuclear waste program contracts decreased by 123 after the amendments were passed, including 113 contracts related to non-Yucca Mountain project work. Spending patterns for nuclear water program contracts have also changed since 1987, with contracts for the Yucca Mountain Project now accounting for a greater percentage of total contract costs. This report also discusses the status of the legal challenge to DOE's selection of Bechtel Systems Management, Inc. as the waste program's management and operating contractor and recent concerns raised about DOE's management of such contracts.

32221 (GSF–10/89) **Report on once-through column experiments with carbon-14.** Klotz, D. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Inst. fuer Hydrologie. 1989. 113p. (In German). Order Number DE90792572. Available from NTIS (US Sales Only), PC A06/MF A01.

The once-through column experiments were done in order to determine the sorption parameters of carbon-14 (retardation factor or dynamic distribution coefficient) in porous media (loose rock, fractured solid rock) under defined experimental conditions (packing density of the porous medium, water velocity). The results were to give information for selection of backfilling material for the projected repository sites at Gorleben and in the Konrad mine. (orig./HP).

32222 (NAGRA-NTB–88-23) **Grimsel test site: laboratory investigations in support of the migration experiments.** Bradbury, M.H. (ed.) (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Apr 1989. 80p. Available from Nagra, CH-5401 Baden, Switzerland.

Tracer migration experiments are in progress at the underground Grimsel Test Site (GTS). In order to interpret field tracer tests a laboratory program is essential. This report describes the results from the first part of such a program. Insufficient material from the protomylonite surrounding the fracture was available from the migration site for the foreseen experiments and so mylonite from an adjacent fault zone was used instead. Petrographic and mineralogical characterisation of the protomylonite and mylonite were carried out. The mylonitic samples from these two sources were mineralogically similar although some potentially significant differences did exist. The protomylonite was slighly depleted in those minerals which could be significant for sorption/exchange processes. This may have consequences for predictions of the sorption behaviour in the migration zone deduced from laboratory measurements. The fracture zone exhibited groundwater discharge at five discrete channels situated in a single fracture. Groundwater emerging from these five locations, and from two boreholes intersecting the plane of the fracture, were sampled and analysed at approximately monthly intervals over a period of 12 months. A series of mylonite-groundwater interaction experiments using natural and synthetic Grimsel groundwaters were carried out at two solid to liquid ratios and two temperatures for times of up to 200 days. On the basis of the measured cation exchange capacity (CEC) and the exchangeable cations on the mylonite, sorption coefficient for Na, Sr, Ca and Mg could be deduced. Estimates of sorption coefficients for these ions under conditions likely to exist in the migration tests were made. Proposals for a number of potentially useful sorbing tracers in the second series of field migration experiments are given together with the conditions under which they are predicted to behave as 'ideal' sorbing tracers.

32223 (NAGRA-NTB–88-25E) **Sediment study - intermediate report 1988: disposal options for long lived radioactive waste in Swiss sedimentary formations: Executive summary.** Lambert, A. (Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland)); McKinley, I. (eds.). Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Jul 1989. 60p. Available from Nagra, CH-5401 Baden, Switzerland.

Nagra report NTB 88-25 provides an extensive review of the possibilities of disposal of vitrified HLW and long-lived ILW in Swiss sedimentary formations. The report consists of two main volumes (text and figures) in German. Because of the extensive international interest in this work, this additional executive summary volume in English has been prepared. The summary emphasises aspects of the work of more general interest and readers are referred to the two main volumes for more detailed discussion (especially of geological topics and hydrodynamic modelling), datasets, figures and references. (author) 9 figs., 10 tabs.

32224 (NAGRA-NTB–88-37) **Grimsel test site: engineering geological investigations into the interpretation of rock stress measurements and fracture system flow tests.** Braeuer, V. (Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hannover (Germany, F.R.)); Kilger, B.; Pahl, A. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Apr 1989. 83p. (In German). Available from Nagra, CH-5401 Baden, Switzerland.

This report describes the basic geological work carried out within the BGR projects 'Rock Stress Measurements' and 'Fracture System Flow Test' at the Grimsel Rock Laboratory/Switzerland. A short introduction into the geology of the Grimsel area is followed by the description of the engineering geological investigations and the evaluation methods applied. The structural geological data resulting formed the basis of the subsequent overall engineering geological evaluation and the tectonic analysis. The relationships between the stress field and the joint system on the one hand and the results of the flow tests on the other are particularly important. Evaluation of the geological data shows structural tectonic and hence rock mechanical and rock hydraulic differences between closely neighbouring rock sections. For this reason this report includes descriptions of the joint system within the area investigated as well as the rock mechanical and rock hydraulic aspects. The engineering geological analysis of both test areas then enables a prognosis to be made of rock stresses and rock hydraulic properties in the full rock area investigated by the BGR. In this manner transferability to other areas is justified. (author) 2 tabs., 24 figs., 21 refs.

32225 (NAGRA-NTB–88-40) **Grimsel Test Site: heat test, final report.** Schneefuss, J. (Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Remlingen (Germany, F.R.). Inst. fuer Tieflagerung); Glaess, F.; Gommlich, G.; Schmidt, M. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). May 1989. 207p. (In German). Available from Nagra, CH-5401 Baden, Switzerland.

The Swiss concept for the storage of radioactive waste consists in placing it in compact, dense rock formations. An experiment 'Heat Test' carried out by the 'Gesellschaft fuer Strahlen- und Umweltforschung' in Nagra's Grimsel rock laboratory simulated the heat production of stored radioactive waste. The aim was to evaluate processes for the demonstration of the suitability of a final repository for heat-producing radioactive waste in cristalline rock, to investigate the thermic, mechanic and hydraulic reactions to an artificial heat source, and to develop corresponding calculating models. The duration of the tests was about 3 years. In this report the measured thermic, mechanic and hydraulic reactions are documented and discussed in detail. A simple, rotation symmetrical FEM-model was used for the preparatory and experiment-accompanying modelling of the thermomechanical conditions in the heat test. The test showed that suitable measuring methods for the surveillance of the geomechanics of a final repository are available and that the reactions of the crystalline host rock to the heat

source remain locally limited and can be modelled with relatively small effort. 29 refs., 33 figs., 10 tabs.

32226 (NAGRA-NTB-89-26) **Borehole sealing: conceptual design and feasibility study.** Brenner, R.P. (Electrowatt Engineering Services Ltd., Zurich (Switzerland)); Jedelhauser, P. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Jun 1989. 149p. (In German). Available from Nagra, CH-5401 Baden, Switzerland.

In this report criteria for sealing boreholes are first considered and the requirements for sealing materials are then specified. For the conceptual design use is made of a multiple-zone borehole plug consisting of key zones and intermediate zones in between. The key zones are located in competent, low-fissured rock and act as efficient barriers to prevent a drain effect by the borehole. Highly compacted bentonite in the form of cylinders with a diameter slightly smaller than that of the borehole and also in the form of spheres or pellets is used as plug material in the key zones, while cement is employed for the intermediate zones. A literature review has revealed that in past experiments mostly cement and bentonite were used as plug materials. The corresponding results showed that both materials are potentially successful candidates. For plug emplacement, it is proposed to employ either a specially designed emplacement tool or a perforated pipe. The latter method is easier to use but the pipe has to remain in the borehole. It is recommended to have a dry density of the bentonite after swelling of not less than 1.3 Mg/m^3. This implies limiting values for the space between the bentonite cylinder and the borehole wall. By means of a bentonite slurry filled into the borehole at the key zone, the allowable ring space can be slightly enlarged. For the use of bentonite in the form of spheres or pellets experimental data are scarce and emplacement procedures are not sufficiently developed to guarantee the required minimum final dry density. In order to check the quality of the plug, an indirect procedure is recommended. For sealing boreholes penetrating into the repository zone, direct quality control is then limited to checking whether the procedure is adhered to as specified and to recording the quantities of materials emplaced. It is shown that the proposed plug design represents an efficient flow barrier.

32227 (PNL–6985) **Evapotranspiration studies for protective barriers: FY 1988 status report.** Link, S.O.; Thiede, M.E.; Evans, R.D.; Downs, J.L.; Waugh, W.J. Pacific Northwest Lab., Richland, WA (USA). May 1990. 39p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE90011055. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In FY 1988, evapotranspiration studies in support of the Protective Barrier Development Program focused on developing instruments to measure evapotranspiration and on conducting natural analog studies. This report describes a has exchange chamber being developed that will control internal temperature and relative humidity to simulate outdoor conditions. This device will measure evapotranspiration rates unambiguously from any surface and measure carbon dioxide exchange rates, which will provide information on plant growth processes. The report also describes ecophysiological experiments that were conducted to determine water and carbon dynamics of shrubs. 5 refs., 24 figs.

32228 (PNL–7209) **Field Lysimeter Test Facility: Second year (FY 1989) test results.** Campbell, M.D.; Gee, G.W.; Kanyid, M.J.; Rockhold, M.L. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 79p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Order Number DE90010859. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

The Record of Decision associated with the Hanford Defense Waste Environmental Impact Statement (53 FR 12449-53) commits to an evaluation of the use of protective barriers placed over near-surface wastes. The barrier must protect against wind and water erosion and limit plant and animal intrusion and infiltration of water. Successful conclusion of this program will yield the necessary protective barrier design for near-surface waste isolation. This report presents results from the second year of tests at the FLTF. The primary objective of testing protective barriers at the FLTF was to measure the water budgets within the various barriers and assess the effectiveness of their designs in limiting water intrusion into the zone beneath each barrier. Information obtained from these measurements is intended for use in refining barrier designs. Four elements of water budget were measured during the year: precipitation, evaporation, storage, and drainage. Run-off, which is a fifth element of a complete water budget, was made negligible by a lip on the lysimeters that protrudes 5 cm above the soil surface to prevent run-off. A secondary objective of testing protective barriers at the FLTF was to refine procedures and equipment to support data collection for verification of the computer model needed for long-term projections of barrier performance. 6 refs.

32229 (PNL–7229) **Remedial Action Assessment System (RAAS): Evaluation of selected feasibility studies of CERCLA [Comprehensive Environmental Response, Compensation, and Liability Act] hazardous waste sites.** Whelan, G. (Pacific Northwest Lab., Richland, WA (USA)); Hartz, K.E.; Hilliard, N.D. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 139p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90010313. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

Congress and the public have mandated much closer scrutiny of the management of chemically hazardous and radioactive mixed wastes. Legislative language, regulatory intent, and prudent technical judgment, call for using scientifically based studies to assess current conditions and to evaluate and select costeffective strategies for mitigating unacceptable situations. The NCP requires that a Remedial Investigation (RI) and a Feasibility Study (FS) be conducted at each site targeted for remedial response action. The goal of the RI is to obtain the site data needed so that the potential impacts on public health or welfare or on the environment can be evaluated and so that the remedial alternatives can be identified and selected. The goal of the FS is to identify and evaluate alternative remedial actions (including a no-action alternative) in terms of their cost, effectiveness, and engineering feasibility. The NCP also requires the analysis of impacts on public health and welfare and on the environment; this analysis is the endangerment assessment (EA). In summary, the RI, EA, and FS processes require assessment of the contamination at a site, of the potential impacts in public health or the environment from that contamination, and of alternative RAs that could address potential impacts to the environment. 35 refs., 7 figs., 1 tab.

32230 (PNL–7258) **SST [single-shell tank] sample characterization analysis of archive samples 102-C, 105-C, and 106-C.** Hara, F.T.; Kaye, J.H.; Steele, R.T.; Stromatt, R.W.; Thomas, D.L.; Urie, M.W. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 90p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE90010854. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

A substantial effort is planned to be initiated at the Hanford Site regarding the characterization of 149 single-shell tanks (SSTs) containing the byproducts of reprocessing during the 1950s and 1960s. Sampling and analysis, in distinct phases, are planned to involve laboratory investigations to determine both chemical and radionuclide inventories, so that waste disposal decisions can be developed. During 1989, trial analyses were performed on four archived samples from SSTs at the Pacific Northwest Laboratory using established U.S. Environmental Protection Agency (EPA) protocols and radiochemical procedures. The analysis of the archived SST waste material provides three important types of data for use in planning Phase 1-A and Phase 1-B sample analysis. The types of data served as input to finalizing the waste sample analysis procedures and methods and identify where procedure development may be needed, evaluating the impact of normal paraffin hydrocarbon (NPH) lubricant (used in field sampling) on extracting inorganics or radionuclides from the SST sample, and identifying trends in amounts of occupational radiation exposure expected from performing the various analysis procedures. 16 figs., 22 tabs.

32231 (PNL–7336) **Geohydrology of the 218-W-5 Burial Ground, 200-West Area, Hanford Site.** Bjornstad, B.N. Pacific Northwest Lab., Richland, WA (USA). May 1990. 198p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Order Number DE90010853. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

Construction a disposal facility for solid, mixed low-level radioactive and hazardous wastes at the Hanford Site in southeastern Washington State (Figure 1) is planned. A site-specific performance assessment for each new disposal facility to ensure that wastes will be isolated from the environment is required. To demonstrate the adequacy of the facility for isolating the wastes, computer codes are used to simulate the physical processes that could cause the waste to migrate to underground water supplies or to the land's surface. The purpose of this report is provide a compilation and interpretation of geologic and hydrologic data available use in the performance assessment modeling. A variety of data are needed to model flow and transport from a solid-waste burial trench. These data include soil water content, soil moisture potential, saturated and unsaturated hydraulic conductivity, and phase mineralogy of the soils and sediments within the vadose zone. The hydrologic data that are critical for quantifying the water storage and transport properties for unsaturated soils require a characterization of the heterogeneities of various soil layers and the moisture characteristic curves for these layers. Hydraulic properties and mineralogic data for the saturated sediments are also important for modelling the flow and transport of wastes in the unconfined aquifer. This report begins with a discussion of the procedures and methods used to gather data both in the field and in the laboratory. This is followed by a summary of the geology, including the stratigraphic framework, lithofacies, and mineralogic/geochemical characteristics of the suprabasalt sediments. The hydrology of the region of the site is discussed next. In this discussion, the characteristics of the uppermost aquifer(s), unsaturated zone, and the various hydrogeologic units are presented. 54 refs., 39 figs., 11 tabs.

32232 (PNL–7341) **Evaluations of the effects of the Columbia River on the unconfined aquifer beneath the 1301-N Liquid Waste Disposal Facility.** Gilmore, T.J.; Borghese, J.V.; McDonald, J.P.; Newcomer, D.R. Pacific Northwest Lab., Richland, WA (USA). May 1990. 93p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE90010852. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Westinghouse Hanford Company (WHC) requested that Pacific Northwest Laboratory (PNL) perform a study to determine what influence the Columbia River has on the aquifer beneath the 1301-N Liquid Waste Disposal Facility (LWDF) located in the 100-N Area. Because of the change in operational status of the N Reactor to "dry layup" in November 1989, there has been a reduction in the liquid effluent discharge to the ground in the 100-N Area. This reduction in discharge reduces the artificial recharge to the unconfined aquifer, thereby altering ground-water flow in the vicinity of the 1301-N LWDF. This study addresses these changes and evaluates the effect that the Columbia River has on the unconfined aquifer beneath the 1301-N facility under present ground-water conditions. 30 refs., 8 figs., 4 tabs.

32233 (RFP–4292) **Selection of immobilization technology for TRU [transuranic] waste.** Roggenthen, D.K. EG and G Rocky Flats, Inc., Golden, CO (USA). 31 Dec 1989. 32p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC34-90DP62349. Order Number DE90010190. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Existing cementation methods for treating Rocky Flats Plant transuranic sludge add weight and volume to the waste. This results in unacceptable increases to shipping and disposal costs. This report contains an analysis of possible technologies for immobilizing wet or dry transuranic sludges that will: meet or exceed current Waste Isolation Pilot Plant acceptance criteria for storage and provide overall waste reduction. Analysis of the possible technologies includes: a survey of Department of Energy defense sites and an inventory of sludge wastes that could be treated with improved technology, a brief description of 14 processes chosen as possible replacements for the cementation process, and a decision analysis using a weighted scoring method for identifying the best processing option. This report summarizes a year-long investigation into possible transuranic (TRU) sludge waste immobilization technologies that should provide a waste form meeting Waste Isolation Pilot Plant (WIPP) acceptance criteria for storage and provide an overall waste volume reduction. The three objectives were to survey the Department of Energy (DOE) defense sites for TRU waste sludges, to identify attractive alternatives to cementing TRU waste sludges, and to select a technology for further development. 22 refs., 2 figs., 8 tabs.

32234 (RFP–4410) **[A small-scale study of Rocky Flats uncalcined incinerator ash dissolution and filtrate anion exchange]: Draft.** EG and G Rocky Flats, Inc., Golden, CO (USA). [1990]. 23p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC34-90DP62349. (CONF-9005161–2: Gatlinburg actinide separations conference, Gatlinburg, TN (USA), 15 May 1990). Order Number DE90010807. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Small scale experimentation was conducted with incinerator ash in the nitric/hydrofluoric acid cascade dissolver and the anion exchange systems at Rocky Flats and Los Alamos National Laboratories for the purpose of determining the following: to determine the relationship between calcium fluoride dissolution feed levels and plutonium dissolution yields. To determine the relationship between calcium fluoride feed levels to dissolution, and the performance of anion exchange when processing dissolution filtrate. To determine the effect of carbonaceous materials on the dissolution and anion exchange when recovering plutonium from incinerator ash.

32235 (SAND–88-0558) **LLUVIA: A program for one-dimensional, steady-state flow through partially saturated porous media.** Hopkins, P.L.; Eaton, R.R. Sandia National Labs., Albuquerque, NM (USA). May 1990. 42p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. Order Number DE90010300. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

LLUVIA is a program designed for the efficient solution of one-dimensional, steady flow through multiple layers of saturated or partially saturated, fractured, porous media. The original intent of the code was to provide initial pressure conditions to two- dimensional, finite element codes. LLUVIA's capabilities were expanded to meet the needs of analyses in the performance assessment of a proposed, high-level nuclear waste repository. The code is based on an adaptive solution method for Darcy's equation and is structured to accommodate user-defined models for hydraulic conductivity and saturation. Program structure, code input, and output are intended to facilitate the interfacing of LLUVIA with graphical and/or statistical software packages. This document describes the flow problem of interest, the solution procedure employed, and the content and content and format of all user-supplied information. A sample problem is also included. 8 refs., 13 figs.

32236 (SAND–89-0201) **Basic data report for drillhole H-12 (Waste Isolation Pilot Plant-WIPP).** Mercer, J.W. (Sandia National Labs., Albuquerque, NM (USA)); Snyder, R.P. Sandia National Labs., Albuquerque, NM (USA). Jan 1990. 72p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC04-76DP00789. Order Number DE90010322. Available from NTIS, PC A04/MF A01; OSTI; INIS.

Drillhole H-12 was drilled where hydraulic data were needed to better establish flow characteristics existing south-southeast of the WIPP site. The fluid-bearing zones of interest are the Magenta and Culebra dolomite units of the Rustler Formation. Dissolution of halite in the Rustler Formation has occurred in the uppermost member, but has not yet begun in the lower halite-bearing members. Cuttings and cores were taken at selected intervals and geophysical logs were run over the entire depth of the hole. 3 refs., 2 figs., 3 tabs.

32237 (SAND–90-0285) **Geomechanical analyses in support of the Waste Isolation Pilot Plant (WIPP).** Ehgartner, B. Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 123p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90010329. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

A variety of geomechanical analyses are presented that support the WIPP project. The scale of the analyses ranged through laboratory experiments, small-scale in-situ tests, large-scale in-situ tests, underground rooms, shafts and shaft keys, and multi-room panels. The structural behavior of underground rooms, shafts, and experiments was investigated using the finite element method.

Both two and three dimensional analyses simulated the time-dependent behavior of the salt host rock. Two different constitutive models were used to represent the creeping motion of the salt. The investigations aided in experimental planning, code validation, and assessing excavation responses for safety and performance assessment. This report compiles ten different structural analyses which assess the performance of excavations and experiments located at the Waste Isolation Pilot Plant (WIPP) in Carlsbad, NM. Chapter 2 discusses the constitutive models used to represent the salt behavior. Each of Chapters 3 through 12 presents an analysis. Chapter 13 concludes the report. 36 refs., 48 figs., 17 tabs.

32238 (SKB-TR--89-18) **Radar investigations at the Saltsjoetunnel - predictions and validation.** Olsson, Olle (Abem AB, Uppsala (Sweden)); Palmqvist, Kai. Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden). 20 Jun 1989. 62p. Order Number DE90628289. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Borehole radar investigations have been performed in two boreholes drilled along the extent of the Saltsjoe tunnel in Stockholm, Sweden. The objective of the project was to test investigate the capabilities of the borehole radar technique to predict geological structures prior to tunnel excavation. Singlehole and crosshole radar measurements were made in the two boreholes which outlined and equilateral triangle. The crosshole data was used to produce tomograms showing the distribution of radar attenuation and slowness (inverse of velocity) in the plane between the boreholes. The radar model of the site contained one major feature which was identified as a fracture zone. The intersection of the fracture zone with the tunnel was extrapolated from the radar data and found to be in agreement with observations in the tunnel. At the intersection of the fracture zone with the tunnel grouting had to be applied. It has also been found that the radar identifies a number of smaller features which are of practically no significance with respect to tunnel construction. There is general agreement between the radar model of the site and the geologic-tectonic model of the site. This project has demonstrated the capability of the boreholes radar technique to predict the existence, location, and orientation of geologic features (e.g. fracture zones) which can be of significance to the cost and safety when excavating a tunnel. However, further development is needed to be able to use the technique cost effectively for continuous prediction ahead of the tunnel front. (authors) (17 figs., 1 tab.).

32239 (UCRL--100211) **Modeling of Zircaloy cladding degradation under repository conditions.** Santanam, L. (Auburn Univ., AL (USA). Dept. of Materials Engineering); Raghavan, S.; Chin, B.A.; Shaw, H. Lawrence Livermore National Lab., CA (USA). Jul 1989. 28p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-48. (CONF-890928--23: Nuclear waste isolation in the unsaturated zone: FOCUS '89, Las Vegas, NV (USA), 18-21 Sep 1989). Order Number DE90011467. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Two potential degradation mechanisms, creep and stress corrosion cracking, of Zircaloy cladding during repository storage of spent nuclear fuel have been investigated. The deformation and fracture map methodology has been used to predict maximum allowable initial storage temperatures to achieve a thousand year life without rupture as a function of spent-fuel history. A stress analysis of fuel rods has been performed. Stresses in the outer zirconium oxide layer and the inner Zircaloy tube have been predicted for typical internal pressurization, oxide layer thickness, volume expansion from formation of the oxide layer and thermal expansion coefficients of the cladding and oxide. Stress relaxation occurring in-reactor has also been taken into account. The calculations indicate that for the anticipated storage conditions investigated, the outer zirconium oxide layer is in a state of compression thus making it unlikely that stress corrosion cracking of the exterior surface will occur. 20 refs., 6 figs., 9 tabs.

32240 (USGS--90-113) **Water levels in periodically measured wells in the Yucca Mountain Area, Nevada, 1988.** Gemmell, J.M. Geological Survey, Denver, CO (USA). 1990. 52p. Sponsored by U.S. DOE Radioactive Waste Management; U.S. Geological Survey. DOE Contract AI08-78ET44802. Order Number DE90010656. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

This report presents water-level data for 10 wells that were periodically measured in 1988 in the Yucca Mountain Area, Nevada. Water levels measured during 1987 are included in the report for reference. The report includes discussions of the methods used and corrections applied to obtain water-level depths and altitudes from onsite measurements. Water levels for each well are presented in tabular and graphical (hydrograph) form. The altitude of the water level in the upper part of the saturated zone is about 775 meters above sea level to the west of and along part of the crest of Yucca Mountain; along the eastern edge and southern end of Yucca Mountain, the water level is 728 to 730 meters above sea level. The water-level data were obtained to help evaluate the suitability of the area for storing high-level nuclear waste. 14 refs., 2 figs., 2 tabs.

32241 (WSRC-RP--89-901) **WIPP/SRL [Waste Isolation Pilot Plant/Savannah River Laboratory] in-situ tests: MIIT [Materials Interface Interactions Tests] program--Glass/metal interfaces of SRS waste glass.** Covington, J.F. Jr.; Wicks, G.G. Westinghouse Savannah River Co., Aiken, SC (USA). 5 Nov 1989. 38p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90011239. Available from NTIS, PC A03/MF A01 - OSTI.

In 1986, approximately 2000 samples of waste glasses and proposed package components were buried in the salt formation at the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico. These samples are part of a five year study, called the Materials Interface Interactions Tests (MIIT), being managed by Savannah River Laboratory [SRL] and Sandia National Laboratory [SNL]. MIIT involves the active participation of eight countries, including Belgium, Canada, France, Germany, Japan, Sweden, the United Kingdom, and the United States. The main objective of the present study is to investigate the interactions of SRL Y (165/TDS) waste blass with proposed metal canister or overpack materials, and more specifically, to determine what effect these metals have on leaching of the SRL waste glass system. Metal systems studied include 304L stainless steel, TiCode-12, lead, and A216 carbon steel. Analyses were performed using scanning electron microscopy [SEM] along with complementary energy dispersive x-rays [EDX]. These results are then correlated to an earlier MIIT study which assessed the behavior of the same SRL waste glass system in WIPP but without metal present. 9 refs., 28 figs., 3 tabs.

32242 (WSRC-RP--89-1348) **Control loop and unit operational realtime modeling on a Distributed Control System.** Rueter, K. Westinghouse Savannah River Co., Aiken, SC (USA). [1990]. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-900494--5: 1990 SCS Eastern multiconference, Nashville, TN (USA), 23-29 Apr 1990). Order Number DE90011249. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Defense Waste Processing Facility (DWPF) will be primarily controlled by a Distributed Control System (DCS). The magnitude of the DWPF process requires that an ample amount of realistic and effective process and procedure oriented training take place on the DCS as a prerequisite for safe and efficient operation of the plant. To help ensure that the training coal will be accomplished, the decision was made to develop a series of simulation packages that deal with selected sections of the process. These simulation packages are executed not on a mainframe computer, as is the same DCS structure built to control the process. This paper will provide a review of the advantages and disadvantages of this approach and an in-depth discussion on the development of the concept of "Functional Simulation" and how it was used to generate these DCS-oriented Process Simulation packages. 5 refs., 7 figs.

32243 (WVDP--90AR) **West Valley Demonstration Project annual report to Congress.** West Valley Nuclear Services Co., Inc., West Valley, NY (USA). Jan 1990. 30p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-81NE44139. Order Number DE90010336. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

By the end of the fiscal year, the West Valley Demonstration Project had processed 757,000 litres of liquid high-level waste, removing most of the radioactive constituents by ion exchange. The radioactive ion exchange material is being stored in an underground tank pending its incorporation, along with sludge still in the tank, into borosilicate glass. The decontaminated salt solution was solidified into a cement low-level waste form which has been reviewed and endorsed by the Nuclear Regulatory Commission. Five tests of the waste glass melter system were completed. A Notice of Intent was published to prepare a joint federal/state Environmental Impact Statement. Design of the Vitrification Facility, a major milestone, was completed and construction of the facility enclosure has begun. A Department of Energy Tiger Team and Technical Safety Appraisal of the Project found no undue risks to worker or public health and safety or the environment.

32244 **Feasibility testing of in situ vitrification of uranium-contaminated soils.** Ikuse, H. (Mitsubishi Metal Corp., Tokyo (Japan)); Tsuchino, S.; Tasaka, H.; Timmerman, C.L. 141-148 of Low and intermediate level radioactive waste management. Feizollahi, F.; Kohout, R.; Suzuki, A. American Society of Mechanical Engineers, New York, NY (USA) (1989). (CONF-891006--: Joint international waste management conference, Kyoto (Japan), 23-28 Oct 1989).

Process feasibility studies using in situ vitrification (ISV) were successfully performed on two different uranium-contaminated wastes. In situ vitrification is a thermal treatment process that converts contaminated soils into durable glass and crystalline form. Of the two different wastes, one waste was uranium mill tailings, while the other was uranium-contaminated soils which had high water contents. Analyses of the data from the two tests are presented.

32245 **Immobilization of technetium in blast furnace slag grouts.** Spence, R.D. (Quality and Technical Services Div., Oak Ridge Gaseous Diffusion Plant, Oak Ridge, TN (US)); McDaniel, E.W.; Gilliam, T.M. 251-254 of Low and intermediate level radioactive waste management. Feizollahi, F.; Kohout, R.; Suzuki, A. American Society of Mechanical Engineers, New York, NY (USA) (1989). DOE Contract AC05-84OR21400. (CONF-891006--: Joint international waste management conference, Kyoto (Japan), 23-28 Oct 1989).

Blast furnace slags have been successfully used to reduce the leachability of technetium from cement-based waste forms, ostensible because the slag produces a less permeable product or reduces the pertechnetate to a less mobile form. Waste contaminated with technetium is of particular concern to the U.S. Nuclear Regulator Commission, Department of Energy, and Environmental Protection Agency because of its mobility as the pertechnetate ion. The technetium leachabilities of cement-based waste forms with and without a slag component and for different slags are presented. The mass transfer parameter (e.g., diffusivity) for leaching technetium from these waste forms decreased by five orders of magnitude when slag was used (i.e., using slag can increase the ANS 16.1 leachability index by five). Results of bulk and surface examinations of the slags are presented.

32246 **Monazite.** Boatner, L.A. (Solid State Division, Oak Ridge National Lab., Oak Ridge, TN (US)); Sales, B.C. 495-564 of Radioactive waste forms for the future. Lutze, W.; Ewing, R. C. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1988). DOE Contract AC05-84OR21400.

Monazite nuclear waste ceramics represent one member of a class of waste disposal materials whose development was predicted on examinations of the established stability of well-characterized mineralogical systems. In particular, this naturalistic approach resulted in the advancement of both the monazite concept and the Synroc concept. (The Synroc waste form consists of titanate-based minerals and is treated elsewhere in this volume.) The idea for using a nuclear waste disposal medium based on a synthetic analogue of the mineral monazite was developed by considering the unusual combination of desirable features of this material. These characteristics are detailed in the article.

32247 **Initial operation of liquid waste treatment at the West Valley demonstration project.** McIntosh, T.W. (U.S. Dept. of Energy, Office of Remedial Action and Waste Technology, Washington, DC (US)); Bixby, W.W.; Maestas, E. 563-566 of Low and intermediate level radioactive waste management. Feizollahi, F.; Kohout, R.; Suzuki, A. American Society of Mechanical Engineers, New York, NY (USA) (1989). (CONF-891006--: Joint international waste management conference, Kyoto (Japan), 23-28 Oct 1989).

In 1980, the United States Congress passed the West Valley Demonstration Project Act (PL 96-368) authorizing the Department of Energy to carry out a high-level radioactive waste management demonstration project at West Valley. The scope of the Project includes solidification of liquid high-level waste; development of high-level waste storage containers; transportation of high-level waste to a federal repository; disposal of low-level and transuranic wastes resulting from the solidification of the high-level waste; and decontamination and decommissioning of the tanks and facilities in which the liquid high-level waste was stored as well as the facilities used to solidify the waste and the material and hardware used in connection with the project. this paper provides an up-to-date report of the status through the Spring 1989 of the treatment of liquid radioactive waste at West Valley.

32248 **Program for low-level radiactive waste disposal at the Savannah River Site, a U.S. nuclear materials production facility.** Wilhite, E.L. (Westinghouse Savannah River, Savannah River Site, Aiken, SC (US)); Cook, J.R.; McDonell, W.R. 573-580 of Low and intermediate level radioactive waste management. Feizollahi, F.; Kohout, R.; Suzuki, A. American Society of Mechanical Engineers, New York, NY (USA) (1989). (CONF-891006--: Joint international waste management conference, Kyoto (Japan), 23-28 Oct 1989).

This paper discusses an integrated program for disposal of low-level radioactive wastes and associated mixed (radioactive-hazardous) and transuranic (TRU) wastes generated at the Savannah River Site (SRS). The program, supported by existing as well as new planned facilities, features a systems management approach, in which final disposal sites are specially designed and constructed for appropriately segregated waste streams, and intermediate treatment facilities are provided to reduce volumes and convert wastes to stable forms prior to disposal. Currently existing shallow land burial facilities are comprehensively monitored for release of contaminants to underlying groundwaters, with only short-lived tritium exhibiting significant migration. Transport modeling is employed to define closure procedures capable of preventing long-term contamination. New facilities to be provided for disposal of the low-level radioactive wastes feature concrete-stabilized wasteforms contained within vault structures that are capable of restricting releases including tritium and other radionuclides to acceptably low levels. Future development studies will center around waste minimization initiatives.

32249 **Buried waste program at the Idaho National Engineering Laboratory.** Bonzon, C.J. (Idaho National Engineering Lab., Idaho Falls, ID (USA)); Fogdall, S.P. 549-554 of Low and intermediate level radioactive waste management. Feizollahi, F.; Kohout, R.; Suzuki, A. American Society of Mechanical Engineers, New York, NY (USA) (1989). DOE Contract AC07-76ID01570. (CONF-891006--: Joint international waste management conference, Kyoto (Japan), 23-28 Oct 1989).

Recent findings from current environmental monitoring activities have determined that migration of transuranic (TRU) radionuclides to the 34-meter sedimentary interbed has occurred beneath the Idaho National Engineering Laboratory (INEL) Radioactive Waste Management Complex. Halogenated hydrocarbons have also been detected in the Snake River Plain Aquifer, which is 177 meters below the Radioactive Waste Management Complex. A Buried Waste Program has been established to determine sources, characterize the extent of contamination, mitigate further migration of TRU and nonradioactive hazardous materials from the Radioactive Waste Management Complex, and provide the mechanism for selecting a permanent solution to migration. This paper discusses cleanup of a federal facility, specifically the Subsurface Disposal Area within the INEL's Radioactive Waste Management Complex. The paper also discusses remediation of the radioactive site, which is co-contaminated with hazardous materials. Corrective measures to be

recommended for remediation of the radioactive waste management complex are scheduled to be announced in September 1990.

32250 FUETAP concrete. McDaniel, E.W. (Chemical Technology Div., Oak Ridge National Lab., Oak Ridge, TN (US)); Delzer, D.B. 565-588 of Radioactive waste forms for the future. Lutze, W.; Ewing, R. C. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1988). DOE Contract AC05-84OR21400.

Cement-based waste forms have been used for several decades to immobilize low-level radioactive wastes. With the appropriate formulation for a given waste, the forms - whether as grout sheets placed in shale fractures deep underground, mixed with soil in a trench, or as monoliths in shallow-land burial - can be provided with the ability to immobilize various low-level radioactive components and with adequate compressive and tensile strength to ensure their durability for many years without cracking or disintegration. Because of the high activity inherent in high-level wastes, the incorporation of these wastes into cementitious forms can cause problems such as gas-pressure build-up from pore water radiolysis and expansion and subsequent cracking from the wastes' thermal activity, either of which can result in the release of radionuclides into the environment. This article discusses FUETAP concretes which utilize the thermal power of the waste to accelerate the curing process. If necessary, heat is also applied externally. In the end, a hard, dense product is obtained from which more than 98% of the unbound water has been driven off; the problems of radiolytic decomposition and thermal expansion become negligible.

32251 Public understanding of radioactive waste management issues: Perspectives and the IAEA's role. Thomas, K.T. (International Atomic Energy Agency, Vienna (Austria). Div. of Nuclear Fuel Cycle and Waste Management); Squires, D.J. *International Atomic Energy Agency Bulletin (Austria),* 31(4): 51-54 (1989).

This paper will address the waste disposal issue as it is one of the important ones being raised concerning acceptance of nuclear power. In a discussion of this issue two facts have to be recognized. The first is that wastes already exist in all countries having nuclear programmes and require safe management and disposal. The second is that adequate technology exists for doing this.

0530 Environmental Aspects

Refer also to citation(s) 32212, 32214, 32248, 32249, 32253, 32809

32252 Low-level radioactive waste management in the United States. Ozaki, C.B. (Idaho National Engineering Lab., Idaho Falls, ID (USA)); Shilkett, R.C.; Kirkpatrick, T.D. 127-132 of Low and intermediate level radioactive waste management. Feizollahi, F.; Kohout, R.; Suzuki, A. American Society of Mechanical Engineers, New York, NY (USA) (1989). DOE Contract AC07-76ID01570. (CONF-891006–: Joint international waste management conference, Kyoto (Japan), 23-28 Oct 1989).

A primary objective of low-level radioactive waste management in the United States is to protect the health and safety of the public and the quality of the environment. In support of this objective is the development of waste treatment and disposal technologies designed to provide stabilization and long-term institutional control of low-level radioactive wastes. Presented herein is a technical review of specific low-level radioactive waste management activities in the United States. Waste treatment and disposal technologies are discusses along with the performance objectives of the technologies aimed at protecting the health and safety of the public and the quality of the environment.

0540 Health and Safety

Refer also to citation(s) 32197, 32202, 32209, 32210, 32229, 32230, 33596, 33606

32253 (CONF-9004181–2) **The environmental compliance process at New York FUSRAP [Formerly Utilized Sites Remedial Action Program] sites.** Devgun, J.S.; Beskid, N.J. Argonne National Lab., IL (USA). [1990]. 16p. Sponsored by U.S. DOE Conservation & Renewable Energy; U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From DOE Remedial Action Program conference; Albuquerque, NM (USA); 16-19 Apr 1990. Order Number DE90011182. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Five sites in New York State are undergoing remedial action planning under the Department of Energy's (DOE) Formerly Utilized Sites Remedial Action Program (FUSRAP). The Colonie site is located in the Town of Colonie, about 4 miles northwest of downtown Albany. The other four sites (Ashland 1, Ashland 2, Seaway, and Linde) are located in the Town of Tonawanda, just north of Buffalo, and are collectively known as the Tonawanda site. None of the New York FUSRAP sites is on the National Priorities List (NPL). The Tonawanda sites were included in FUSRAP between 1980 and 1984 because the radioactive material at these sites originated from activities performed for the Manhattan Engineer District (MED) in the 1940s. The Colonie site was assigned to DOE by the US Congress as part of a decontamination research and development project under the 1984 Energy and Water Appropriations Act. DOE is proposing to conduct remedial action planning and remedial action activities at these sites following an integrated approach to comply with the requirements of both the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Environmental Policy Act (NEPA). 5 figs.

32254 (KURRI-TR–325) **Proceeding of the symposium on the plan for establishment of Health Physics Research Center.** Tsujimoto, Tadashi; Mizuma, Mituro; Ishida, M.R. (eds.). Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. Dec 1989. 44p. (In Japanese). (CONF-8908228–: Symposium on the plan for establishment of Health Physics Research Center, Kumatori (Japan), 8 Aug 1989). Order Number DE90791143. Available from NTIS (US Sales Only), PC A03/MF A01.

The purposes of the establishment of the Health Physics Research Center are for much more development of health physics researches in higher level and systematic educations for the younger researchers. This research center was planned out for the co-operative research institute where can be used by not only visiting researchers of universities and academic institutions in Japan but also foreign researchers. The establishment of the Research Center has been authorized by the Japan Academy of Science in 1983, and the requests for obtaining the funds of the establishment has been carried out by the Kyoto University Authority to the Ministry of Education, Science and Culture, Japanese Government in 1984. In this academic year, 1989, a symposium on the plan for the establishment of the Health Physics Research Center was held as one of the activities of Health Physics Research Meeting at Research Reactor Institute. The attendants was more than 120 scientists, and many valuable comments have been stated for the plan on the establishment. This report includes these comments. We editors many tank to the commentators and discussors. We hope to give much more cooperation and supports to the plan for the establishment of the Health Physics Research Center. (author).

32255 (PB–90-179276/XAB) **NIOSH (National Institute for Occupational Safety and Health) Testimony on the safety of nuclear facility workers by P. J. Bierbaum on April 22, 1985.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 22 Apr 1985. 18p. Available from NTIS, PC A03/MF A01.

The testimony concerned the National Institute for Occupational Safety and Health (NIOSH) activities related to the health and safety of workers employed at nuclear facilities. Three NIOSH studies were noted, including an evaluation in progress at the Feed Materials Production Center in Fernald, Ohio, a study of radiation exposure at the Goodyear Atomic Corporation (GAC) in Piketon, Ohio, and a study of deaths from cancer at the Portsmouth Naval Shipyard in Kittery, Maine. In the first study the union representatives at the FMPC had several health and safety issues that they wanted NIOSH to evaluate. Additional requests have been made by the union at this facility in relation to reported uranium releases from the site. NIOSH recommended that all potentially exposed workers undergo bioassay testing to determine lung burdens of uranium. At GAC workers requested an evaluation because of exposure to radiation from uranium hexafluoride. Total mortality for radiation workers was significantly below that expected, including cancer deaths, even those from leukemia. Total mortality for nonradiation-exposed workers indicated an increase in the number

of deaths due to leukemia. In a further study a significantly increased risk for workers whose cumulative lifetime exposure was at least 1.00 rem was noted for malignancies of the trachea, bronchus, or lung.

0550 Safeguards, Inspection, and Accountability

32256 (INIS-mf-12597) **Council for Nuclear Safety annual report 1988/89.** Council for Nuclear Safety, Verwoerdburg (South Africa). 1989. 58p. (In English, Afrikaans). Order Number DE90628330. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

An overview of the structure, duties and activities of the Council for Nuclear Safety during 1988/1989 is presented in this annual report. It is the Council's first duty to ensure that all aspects - siting, design, construction and operation - in all areas of the nuclear industry, from mining of the nuclear ores to the ultimate disposal of nuclear waste, are conducted in such a manner that the potential for harm associated with the radioactive properties of the materials involved is kept under proper control. In order to achieve this the Council is responsible for the establishment and application of safety standards, the issuing of nuclear licenses and the evaluation and inspection of nuclear installations to ensure that the licensees are complying with the conditions laid down in the license and that they are adhering to all the safety criteria established by the Council. Other information contained in this annual report is, inter alia, the financial statements of the Council, the meetings attended by members of the Council and the administrative and management aspects of the Council. 8 figs.

32257 (KFK-4680) **Application of near réal time accountancy to nuclear material balance data.** Seifert, R. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Datenverarbeitung in der Technik; Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Wiederaufarbeitung und Abfallbehandlung. Feb 1990. 45p. (PWA-71/89). Order Number DE90792464. Available from NTIS (US Sales Only), PC A03/MF A01.

IBM 3090; FORTRAN 77.

The application of near real time accountancy to nuclear material balance data can be performed effectively only with the help of computerised nuclear material accounting and information systems. Two computer programmes are introduced: DIDI, a programme for computing the MUF series and the measurement model of a reprocessing plant which is assumed to be a one-block model from data resulting from the routine operation of the facility, and PROSA, a programme for statistical analysis of NRTA data, which evaluates the MUF series on the basis of the measurement model. After the presentation of the two computer programmes two examples with realistic balance data will demonstrate the application of NRTA measures. Furthermore, some new remarks on the precision of Monte-Carlo simulations are mentioned which provide a substantial better estimation. (orig.).

32258 (LA-UR-90-1372) **Applications of gamma-ray spectrometry in the quantitative nondestructive assay of special nuclear materials.** Sampson, T.E.; Parker, J.L. Los Alamos National Lab., NM (USA). 16 Apr 1990. 25p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900563-4: 7. symposium on radiation measurements and applications, Ann Arbor, MI (USA), 21-24 May 1990). Order Number DE90010609. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Nearly all applications of gamma-ray spectrometry in the quanitative assay of special nuclear materials can be grouped into five general categories. They are as follows: (1) Quanitative passive assay, of which transmission-corrected passive assay methods for measuring isotopic masses/concentrations are an important subset; (2) Enrichment measurements on "infinitely thick" samples for absolute determination of isotopic fractions/concentrations; (3) Measurements of isotopic ratios using relative detection efficiency principles resulting in absolute isotopic distributions without recourse to standards; (4) Absorption-edge densitometry measurements of elemental concentrations; and (5) X-ray fluorescence measurements of elemental concentrations. Careful and correct practice of these techniques can yield measurement accuracies in the range of 0.1% to 1.0% in favorable situations with measurement times generally in the range of 15 minutes to 1 hour. We present examples of these general categories with emphasis on those measurements and techniques exhibiting the best accuracy, as well as those which are not routinely practiced in many other applications of gamma-ray spectrometry. 20 refs., 6 fig.

32259 (PB-90-184284/XAB) **Manual of protective actions for nuclear incidents.** Office of Radiation Programs, Washington, DC (USA). Jan 1990. 245p. (EPA-520/1-75/001-A). Available from NTIS, PC A11/MF A02.

This manual presents a general discussion of Protective Action Guides (PAGs) and their use in planning for protective actions to safeguard public health. It also presents PAGs for specific exposure pathways and associated time periods. The PAGS apply to all types of nuclear incidents. Guidance for the implementation of PAGs that emphasizes the application to nuclear power facilities is included.

0560 Legislation and Regulations

Refer also to citation(s) 32205, 32328, 33605

07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY

0702 Radiation Sources

Refer also to citation(s) 32915, 32933

32260 (PB-90-176942/XAB) **On-line monitor for metallic wear products. Phase 1. Final report.** Squillante, M.R.; Borowski, K.; Frederick, E. Radiation Monitoring Devices, Inc., Watertown, MA (USA). 31 Aug 1987. 26p. Available from NTIS, PC A03/MF A01.

Research was conducted with the goal of demonstrating the feasibility of designing a novel nondestructive, radiometric instrument to accurately quantify the levels of iron, titanium, and other metals in circulating lubricating media at the tens of parts-per-million (ppm) concentration level. The laboratory apparatus for conducting the research was straightforward and consisted of a vertical cylindrical tube with x-ray transparent ends, a radioactive source at one end of the tube, a detector and associated electronics at the other end, and a multichannel analyzer. The tube was repetitively filled to various levels by lubricating media containing various minute amounts of iron on titanium. The data were acquired and analyzed for the direct purpose of determining the ultimate sensitivity. Researchers found that the instrument could detect 10 ppm of iron and 15 ppm of titanium concentration levels in the lubricating medium once the experimental setup was optimized.

32261 **Time-resolved solid-state array imaging system: Developments and applications.** Koehler, H.A. (Lawrence Livermore National Lab., Livermore, CA (US)). 740-748 of Proceedings of the 18th international congress on high speed photography and photonics. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). DOE Contract W-7405-ENG-48. (CONF-8808103-: 18. international congress on high-speed photography and photonics, Xian (China), 28 Aug - 2 sep 1988).

Several optical, single transient data imaging systems have been developed at the Lawrence Livermore National Laboratory for providing time-, space-, and intensity information of pulsed radiation sources. The basic components of these systems are fast-gated cameras, large bandwidth transmission lines, large memories and image processors. Gated MCPI are used with solid-state, one- or two-dimensional array cameras to record individual frames of an optical pulse. The MCP intensifiers are designed to provide large gain ($< 10^{-6}$ electrons), fast optical shutter ($\leq$ 1 nsec), low shading ($\leq$ 10%), high spatial resolution (10 lp/mm at 50% CTF), and high sensitivity in the near UV (420 nm). Several methods are currently investigated to produce faster optical gates without significant irising or reduction in resolution, and to improve spatial resolution. Both photodiode arrays and charge-coupled devices (CCD) are used for the imagers in the solid-state cameras. These

cameras are designed to achieve a large dynamic range (500:1), low saturation fluence ($\leq$ 1.5 erg/cm^2 at 420 nm), and small frame time ($\leq$ 2.5 msec). Several commercially available imaging arrays containing 1035 x 1320, 512 x 512, 488 x 380, 128 x 128, 100 x 100 pixels each, with pixel diode sizes of $\geq$ 15 μ, are examined for blooming, cross-talk, blemishes, and uniformity. Current investigations are concentrating on large segmented (512 x 512) photodiode arrays with CCD readout. All cameras are designed for fiber-optic or lens coupling.

0703 Isotopic Power Supplies

32262 (WHC-SA-0881) **Assembly of radioisotope power systems at Westinghouse Hanford Company.** Alderman, C.J. Westinghouse Hanford Co., Richland, WA (USA). Apr 1990. 14p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. (CONF-9006178--1: 1990 Society of Women Engineers national convention and student conference, New York, NY (USA), 24 Jun - 1 jul 1990). Order Number DE90010851. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Long-term space flight requires reliable long-term power sources. For the purpose of supplying a constant supply of power in deep space, the radioisotope thermoelectric generator has proven to be a successful power source. Westinghouse Hanford Company is installing the Radioisotope Power Systems Facility which is located in the Fuels and Material Examination Facility on the Hanford Site near Richland, Washington, for assembling the generators. The radioisotope thermoelectric generator assembly process is base upon one developed at Mound Laboratory in Miamisburg, Ohio (presently operated by EG&G Mound Applied Technologies). Westinghouse Hanford Company is modernizing the process to ensure the heat source assemblies are produced in a manner that maximizes operator safety and is consistent with today's environmental and operational safety standards. The facility is being prepared to assemble the generators required by the National Aeronautics and Space Administration missions for CRAF (Comet Rendezvous Asteroid Flyby) in 1995 and Cassini, an investigation of Saturn and its moons, in 1996. The facility will also have the capability to assemble larger radioisotope power generators designed for dynamic power generation. 4 refs., 11 figs.

0704 Economic, Industrial, and Business Aspects

32263 (N-90-15836, pp. 97-149) **Transportation and operations aspects of space energy systems.** Woodcock, G.R. National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center. Jul 1989. (NASA-TM-101652;NAS-1.15:101652). In *Report of NASA Lunar Energy Enterprise Case Study Task Force.* Available from NTIS, PC A09/MF A02.

A brief comparative analysis was made for three concepts of supplying large-scale electrical energy to Earth from space. The concepts were: (1) mining helium-3 on the Moon and returning it to Earth; (2) constructing solar power satellites in geosynchronous orbit from lunar materials (the energy is beamed by microwave to receivers on Earth); and (3) constructing power collection and beaming systems on the Moon itself and transmitting the energy to Earth by microwave. This analysis concerned mainly space transportation and operations, but each of the systems is briefly characterized to provide a basis for space transportation and operations analysis.

0705 Health and Safety

Refer also to citation(s) 32262, 33596

08 HYDROGEN

0801 Production

Refer also to citation(s) 32050

32264 (PB-90-169038/XAB) **Development of methanol reformer.** Imai, T.; Yanagi, M.; Kuroda, K. Mitsubishi Heavy Industries Ltd., Tokyo (Japan). c 1989. 6p. Available from NTIS, PC A06/MF A01.

Text in Japanese. Pub. in Mitsubishi Juko Giho, Vol. 26, No. 5, 408-412(1989).

The methanol steam reforming process by which methanol is catalytically decomposed into hydrogen and carbon dioxide can be applied to a great variety of fields, such as the products of hydrogen for fuel cells or liquid hydrogen. Practical use of the process will accelerate with a stable supply and cost reduction of methanol. In conventional plants for the production of hydrogen, the heat for heating, vaporizing and reforming is supplied from outside the tube by a heating medium which has been heated in a furnace. The authors have developed a new type of methanol reformer with a gas production capacity of about 5 cu Nm/h which introduces a direct heating system using combustion gas as the heat source. The report presents features of a catalyst for the methanol steam reforming process developed by MHI, features of the methanol reformer developed by MHI, and combined operation test results of a methanol reformer with fuel cell.

0805 Health and Safety

Refer also to citation(s) 32265

0810 Waste Management

32265 (LA-UR-90-753) **Safe venting of hydrogen.** Stewart, W.F.; Dewart, J.M.; Edeskuty, F.J. Los Alamos National Lab., NM (USA). [1990]. 14p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-900705--2: 8. world hydrogen energy conference, Honolulu, HI (USA), 22-27 Jul 1990). Order Number DE90008964. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The disposal of hydrogen is often required in the operation of an experimental facility that contains hydrogen. Whether the vented hydrogen can be discharged to the atmosphere safely depends upon a number of factors such as the flow rate and atmospheric conditions. Calculations have been made that predict the distance a combustible mixture can extend from the point of release under some specified atmospheric conditions. Also the quantity of hydrogen in the combustible cloud is estimated. These results can be helpful in deciding of the hydrogen can be released directly to the atmosphere, or if it must be intentionally ignited. 15 refs., 5 figs., 2 tabs.

0830 Combustion

Refer also to citation(s) 32838

09 BIOMASS FUELS

0908 Production

Refer also to citation(s) 32092

0909 Processing

32266 (BNL-44410) **Biomass and hydrocarb technology for removal of atmospheric CO_2.** Steinberg, M. Brookhaven National Lab., Upton, NY (USA). Mar 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900705--3: 8. world hydrogen energy conference, Honolulu, HI (USA), 22-27 Jul 1990). Order Number DE90010016. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

All mitigation scenarios proposed to date either tend to slow down the rate of atmospheric CO_2 emissions or level out the CO_2 concentration in the atmosphere. A unique system has been devised which offers a method of actually reducing the CO_2 concentration in the atmosphere while still generating energy from fossil fuel. The only economically and technically reasonable

method for removal of CO_2 from the atmosphere is by the process of solar photosynthesis which extracts carbon from atmospheric CO_2 by formation of biomass, e.g., hemi-cellulose. The biomass is then thermochemically converted by the HYDROCARB technology with fossil fuel, gas, oil or coal to produce carbon black and methanol. The carbon is returned to the earth, for long-term storage, while the methanol is used as fuel. There is also an energy enhancement in utilizing gas and oil for producing methanol compared to conventional methanol processes using these fuels. Co-processing with coal results in no net CO_2 generated or removed per unit of methanol energy generated; however, a 2% increase in coal utilization is realized compared to conventional steam refining and methanol production. The process chemistry system is described and quantified in this paper. 11 refs.

32267 (DOE/ER/13370–1) **[Conversion of acetic acid to methane by thermophiles]: Progress report, May 15, 1985–May 15, 1990.** Zinder, S.H. Cornell Univ., Ithaca, NY (USA). Dept. of Microbiology. [1990]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-85ER13370. Order Number DE90010993. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The goal of this project is to gain a more complete understanding of the microorganisms converting a lignocellulose waste to methane in a thermophilic (58°C) anaerobic bioreactor. To accomplish this, we have directly examined microbial populations in the bioreactor and have examined the properties of microorganisms isolated from the bioreactor. The primary focus has been on anaerobic thermophiles involved in the formation and degradation of acetic acid, the precursor of two thirds of the methane produced in the bioreactor. Also, novel organisms of fundamental and practical significance have been isolated and characterized. As the project has progressed there has been greater emphasis on the physiology of pure cultures. 7 refs.

0920 Combustion

Refer also to citation(s) 32513, 32525

32268 (FAL-IfBW–4/88) **Repercussion of the production of renewable resources on foodstuff supply and appraisal of policy measures for promoting the production of renewable resources.** Becker, H.; Kleinhanss, W.; Koegl, H. Bundesforschungsanstalt fuer Landwirtschaft, Braunschweig (Germany, F.R.). Inst. fuer Betriebswirtschaft; Bundesministerium fuer Ernaehrung, Landwirtschaft und Forsten, Bonn (Germany, F.R.). Mar 1988. 277p. (In German). Contract 85 NR 014. Order Number DE90791950. Available from NTIS (US Sales Only), PC A13/MF A01.

This publication contains three papers. They ask in how far policy measures can promote the production of renewable resources and which are the conditions determining the maximum suitability of individual policy measures. The three papers are: (A) Resource production as a supporting measure for an agrarian price policy adopting a middle course - a projection for the year 1995, (B) Evaluation of policy instruments for promoting renewable resources, taking into account regionally differentiated land use conditions in the Federal Republic of Germany, and (C) Appraisal of innovations for traditional agrarian products as regards renewable resources for the substitution of energy imports. As all three papers point out, the competitiveness of renewable resources depends above all on the individual content of the agrarian policy, world market prices for agrarian products, other feedstocks and energy sources and the rates of future technical progress in agrarian production, as well as the forms of alternative use envisaged. Renewable resources could be a chance for preserving income capacity in farming if prices for farming products in the EC fall, major factor-saving technical progress is realized, and world market prices for technical and industrial feedstocks, especially crude oil, go up distinctly. Furthermore it is necessary to achieve qualitative technical progress especially in the sector of raw material production, with a view to product innovations departing from the mass products in world trade. (orig./EF).

0930 Economic, Industrial, and Business Aspects

32269 (ETSU-B–1224) **Market review of demand for industrial waste combustors for on-site use.** Department of Energy, London (UK); UKAEA Harwell Lab. (UK). Energy Technology Div.; P-E Inrucon Ltd., Egham (UK). 1989. vp. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

This report summarises the findings of a market study to investigate the potential for using general waste as a fuel source on sites where waste arises. The study was carried out for ETSU acting on behalf of the Department of Energy by P-E Inbucon Limited during the period January to July 1988. General waste is defined as non-specialised waste and includes general packaging, paper, cardboard, plastics, timber and general combustible site waste. The study focuses on manufacturing industry and the retail sector only. The study was initiated by recent advances in waste combustion technology which may make the concept truly viable compared to previous methods. ETSU now wished to review waste arisings and disposal, energy requirements, and the market's attitude towards waste as a fuel in order to assess economic viability and to guide the hardware industry in developing new equipment. (author).

0950 Environmental Aspects

32270 (ORNL/TM–11180) **CO_2 emissions from production and combustion of fuel ethanol from corn.** Marland, G.; Turhollow, A. Oak Ridge National Lab., TN (USA). May 1990. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90010272. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In searching for ways to avoid a climatic change driven by the increasing atmospheric concentration of carbon dioxide, we need to inquire into the possibility of reducing the rate of CO_2 emissions to the atmosphere. Since the initial preparation and distribution of our calculations on CO_2 emissions related to the production and combustion of fuel ethanol from corn, increasing interest in alternative transportation fuels has focused attention and review on this topic and on our calculations. The important challenge is to ascertain if reviewers have discovered defects in our analysis, if they have been able to obtain better data or improved insight over our initial analysis, or if they have come to conclusions that are qualitatively different from ours — given the inescapable uncertainties. The major qualitative different with the numbers and uncertainties presented in our original manuscript is in how one chooses to assign CO_2 emissions among the multiple products of the ethanol production process – i.e., the "by-product credits." We have reexamined our text in the light of specific criticisms that have been expressed to us. Because our original manuscript was so widely circulated and so frequently discussed in what was essentially a draft format, we felt that for most readers the most useful approach to follow in formal publication would be to publish what is essentially the draft document and to respond to both internal and external criticisms in an Addendum. This should allow readers to discern both the evolution and range of thinking. The text published here differs from that circulated as the September 1988 draft only to the extent that systematic conversion to SI units has been completed and a rounding error in Table 1 has been corrected. 26 refs., 5 tabs.

0960 Health and Safety

32271 (SJF-Orientering–65) **Poly aromatic hydrocarbons in flue gas from straw-fueled boilers: Pilot investigation.** Thellesen, H.Z. Statens Jordbrugstekniske Forsoeg, Horsens (Denmark). Afd. for Driftsteknik og Energi. Sep 1989. 24p. (In Danish). Contract TR-88.611. Order Number DE90791324. Available from NTIS (US Sales Only), PC A03/MF A01.

The aim of the project was to discover whether significant amounts of poly aromatic hydrocarbons can be found in smoke emitting from newer types of straw-fueled boilers, and also whether it is found in connection with particle emission. Emission of PAH-4 on 4,0 and 7,5 mug/m3 (n,t) smoke with 10% O2 was found, where fueling was continuous, in a boiler with a good combustion quality. PAH-4 is the group of PAH compounds which is especially

carcinageous. 40 and 95 mug PAH-4 was found in emission from a boiler straw-fueled in portions. PAH emission was found to be dependent on fuel quality. It is not readily found in connection with particle emission. It was concluded that the higher the quality of combustion the less PAH emission resulted, but in this case particle emission was higher. In the case of larger amounts of particle emission the content of soluble salts was larger, but there were less combustible substances. (AB).

0980 Waste Management

Refer also to citation(s) 32271

0990 Products and By-Products

Refer also to citation(s) 32270

10 SYNTHETIC FUELS

1002 Production

Refer also to citation(s) 32266

32272 (PB–90-169012/XAB) **Development of synthetic gasoline-production process.** Imai, T.; Ukawa, N.; Nagakura, F.; Tamai, M.; Suzuki, T. Mitsubishi Heavy Industries Ltd., Tokyo (Japan). c 1989. 7p. Available from NTIS, PC A06/MF A01.

Text in Japanese; Pub. in Mitsubishi Juko Giho, Vol. 26, No. 5, 391-396(1989).

The technology for producing gasoline from synthesis gas is important as a possible means to provide synthetic fuel in the future. Mitsubishi Heavy Industries, Ltd. and Cosmo Oil Co., Ltd. have jointly collaborated in the development of technology for the production of high octane gasoline at high yield from synthesis gas. They succeeded in developing a technology called the Two-Stage STG Process for productions of gasoline from synthesis gas via dimethylether. They constructed a large-scale bench plant having a productive capacity of gasoline of 1 bbl/day. As the large scale bench plant was operated to confirm catalyst performance and the charactreistics of each apparatus, much data for commercializing the process has already been obtained.

32273 (SAND–89-7151) **Evaluation of mixed alcohol production processes and catalysts.** El Sawy, A.H. (Mitre Corp., McLean, VA (USA). Civil Systems Div.). Sandia National Labs., Albuquerque, NM (USA); Mitre Corp., McLean, VA (USA). Civil Systems Div. Apr 1990. 156p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC04-76DP00789. Order Number DE90010325. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

This report presents a technical evaluation of the results of research in the DOE supported program of higher alcohol production and assesses the progress made under this program by both Union Carbide Company and Lehigh University. To the extent possible, the evaluation has included comparison with similar processes that are being developed in Europe by such companies as Lurgi, Snamprogetti and the Institut Francais du Petrole. In addition, the octane market is analyzed and the potential utility of mixed alcohol additives as gasoline octane enhancers and energy extenders is examined. Synthetic mixed alcohol production processes that are now ready for commercialization, as well as areas for further research, are identified. 42 refs., 10 figs., 53 tabs.

32274 **Study of the recombination reaction $CH_3+CH_3 \rightarrow C_2H_6$: Theory.** Wagner, A.F. (Argonne National Lab., IL (USA). Chemistry Div.); Warklaw, D.M. 147-152 of Proceedings of the 1987 spring technical meeting of the Combustion Institute on combustion fundamentals and applications. Combustion Institute, Pittsburgh, PA (USA) (1987). DOE Contract W-31-109-ENG-38. (CONF-870541–: Combustion fundamentals and applications: spring technical meeting of the Central States Section of the Combustion Institute, Argonne, IL (USA), 11-12 May 1987).

A microcanonical variational RRKM rate constant calculation, based on the flexible transition state theory of Wardlaw and Marcus and an adjustable empirical potential energy surface, is compared to measurements of the methyl radical self-recombination rate constant in Ar buffer gas. The calculations contain two adjustable parameters: a potential parameter proportional to, which influences the tightness of the transition state and $\langle \Delta E \rangle_{bit}$, the total average energy change in metastable C_2H_6 per collision with the buffer gas. When the parameters are optimized, the resulting calculated rate constants have a 10.7% rms error with the measurements in Ar buffer gas. The rate calculation have been extended to 2000K and then fit over the full temperature and pressure range to a relatively simple functional form suitable for modeling studies.

1003 Properties and Composition

Refer also to citation(s) 32080

1004 Combustion

Refer also to citation(s) 32838

1008 Waste Management

Refer also to citation(s) 33189

1020 Products and By-Products

Refer also to citation(s) 32181

13 HYDRO ENERGY

1301 Resources and Availability

32275 (AFME–85.05.1016) **Energetic up-grading of wells in arterian basins.** Henou, B.; Maget, P. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). Jun 1986. 230p. (In French). Order Number DE90790625. Available from NTIS (US Sales Only), PC A11/MF A01.

A study, based on a bibliographical survey, concerning the potentials of energetic up-grading of the artesian waters in various countries in the world (North Africa, Saoudit Arabia, Australia) is presented. In Marocco, for example, a turbine is installed on an artesian well and delivers a 15 kW electric production (used for greenhouse lighting). Corrosion characteristics of the waters are examined.

1303 Plant Design and Operation

32276 (NVE-U-R–04-88) **Small hydro electric power development in the northern area, Pakistan: A mission report.** Barth, F.; Husebye, S.; Jensen, T. Norges Vassdrags- og Energiverk, Oslo (Norway). Jan 1989. 101p. Order Number DE90791373. Available from NTIS (US Sales Only), PC A06/MF A01.

The report provides recommendations on the establishment of a mechanical/electrical workshop for improved maintenance of existing power plants in the Northern Area, Pakistan. In addition it provides recommendations on upgrading and refurbishing four small hydroelectric plants, the construction of two new, small hydroelectric plants and studies on medium scaled hydroelectric plants. It is a goal to improve existing construction solutions, focus on spin-off effects like training and transfer of technology, improve the standard of living by making electricity available and reduce pressure on the environment. 6 figs., 4 tabs.

1306 Environmental Aspects

32277 (CONF-891098–3) **Cumulative impact assessment: A case study.** Irving, J.S.; Bain, M.B. Argonne National Lab., IL (USA). [1989]. 32p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract W-31109-ENG-38. From The scientific challenges of NEPA: future directions based on 20 years of experience; Knoxville, TN (USA); 24-27 Oct 1989. Order Number DE90003546. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The National Environmental Policy Act of 1969 (NEPA) indirectly addressed cumulative impacts. Attempts to include cumulative impacts in environmental impact assessments, however, did not began until the early 1980's. One such effort began when The Federal Energy and Regulatory Commission (FERC) received over 1200 applications for hydroelectric projects in the Pacific Northwest. Federal and State Agencies, Indian tribes and environmental groups realized the potential cumulative effect such development could have on fish and wildfire resources. In response, the FERC developed the Cluster Impact Assessment Procedure (CIAP). The CIAP consisted of public scoping meetings; interactive workshops designed to identify projects with potential for cumulative effects, important resources, available data; and preparation of a NEPA document (EA or EIS). The procedure was modifies to assess the cumulative impacts of fifteen hydroelectric projects in the Salmon River Basin, Idaho. The methodology achieved its basic objective of evaluating the impact of hydroelectric development on fish and wildfire resources. In addition, the use of evaluative techniques to determine project interactions and degrees of impact hindered acceptance of the conclusions. Notwithstanding these problems, the studies provided a basis for decision-makers to incorporate the potential effects of cumulative impacts into the decision-making process. 22 refs., 2 figs., 4 tabs.

14 SOLAR ENERGY

Refer also to citation(s) 32472

1401 Resources and Availability

32278 Solar resources. Solar heat technologies: Fundamentals and applications. Hulstrom, R.L. (ed.). 408p. Massachusetts Institute of Technology, Cambridge, MA (1989). Sponsored by U.S. DOE Conservation & Renewable Energy.

Following the 1973 oil embargo, the US government initiated a program to develop and use solar energy. This led to individual programs devoted to developing various solar radiation energy conversion technologies: photovoltaic and solar-thermal conversion devices. Nearly concurrently, it was recognized that understanding the available insolation resources was required to develop and deploy solar energy devices and systems. It was also recognized that the insolation information available at that time (1973) was not adequate to meet the specific needs of the solar energy community. Federal efforts were initiated and conducted to produce new and more extensive information and data. The primary federal agencies that undertook such efforts were the Department of Energy (DOE) and the National Oceanic and Atmospheric Administration (NOAA). NOAA's efforts included activities performed by the National Weather Service (NWS) and the National Climatic Data Center (NCDC). This book has two man objectives: to report some of the insolation energy data, information, and products produced by the federal efforts and to describe how they were produced. Products include data bases, models and algorithms, monitoring networks, instrumentation, and scientific techniques. The scope of products and results does not include all those produced by past federal efforts. The book's scope and subject matter are oriented to support the intent and purpose of the other volumes in this series. In some cases, other pertinent material is presented to provide a more complete coverage of a given subject. 385 refs., 149 figs., 50 tabs.

1405 Solar Energy Conversion

32279 (DOE/ER/13631–17) **Chlorophyll photochemistry in microheterogeneous media.** Tollin, G. Arizona Univ., Tucson, AZ (USA). Dept. of Biochemistry. 11 Dec 1989. 62p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13631. Order Number DE90010963. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The photochemical properties of chlorophyll have received wide attention as a consequence of the primary role of this pigment in the energy conversion events of biological photosynthesis. Recent interest has shifted to the study of a variety of microheterogeneous systems. In the context of the present review, microheterogeneous media refers to the following: lipid bilayers, either vesicular or planar; detergent micelles; microemulsions; and various miscellaneous systems such as polyethylene beads and cellulose nitrate filters. Attention will be focused primarily on those photochemical process and mechanisms which are unique to microheterogeneous systems, and which are especially relevant to energy conversion and storage. 113 refs.

32280 (PB–90-181413/XAB) **Recombinant dna technical bulletin. Volume 12, Number 3, September 1989.** National Insts. of Health, Bethesda, MD (USA). Sep 1989. 67p. (NIH/PUB–90-99-VOL-12-NO-3). Available from NTIS, PC A04/MF A01.

Also available from Supt. of Docs.

The Recombinant DNA Technical Bulletin is a publication of the Office of Recombinant DNA Activities (ORDA), National Institutes of Health (NIH). The Bulletin attempts to link investigators involved in recombinant DNA research with organizations active in this area. It is sent to the chairmen of Institutional Biosafety Committees registered with ORDA, to principal investigators of NIH grants and contracts involving recombinant DNA, to the chairmen of genetic manipulation advisory committees, and to other individuals and groups interested in recombinant DNA activities.

32281 (PB–90-187089/XAB) **Methods to measure the influence of genetically engineered bacteria on ecological processes in soil.** Stotzky, G. New York Univ., NY (USA). Lab. of Microbial Ecology. Jan 1990. 40p. (EPA–600/3-90/011). Available from NTIS, PC A03/MF A01.

The purpose of the document is to summarize the methods and concepts that have been developed and used by the author and his colleagues to study the potential effects of genetically engineered microorganisms (GEMs) introduced, deliberately or accidently, into soil on microbemediated ecological processes in soil. The potential impacts of GEMs on the structure and function of natural environments into which the GEMs are introduced is the bottom-line aspect in the concern about the survival of, and genetic transfer by, GEMs in these habitats. If a GEM survives in the habitat into which it is introduced, does the job for which it was designed, and even if the novel gene(s) is transferred to indigenous microbes, there should be little cause for concern unless the novel gene(s), either in the introduced GEM or in an indigenous recipient(s), results in some unexpected impacts on the environment.

32282 (PB–90-190562/XAB) **Monitoring for genetically engineered pseudomonas species in monterey county.** Supkoff, D.; Opgenorth, D.; Lai, C.; Segawa, R.; Koehler, D. California Dept. of Food and Agriculture, Sacramento, CA (USA). Jan 1987. 23p. Available from NTIS, PC A03/MF A01.

A field monitoring study was conducted to determine if genetically altered Pseudomonas fluorescens or P. syringae had been applied to sites in Monterey County. A series of diagnostic tests for antibiotic resistance, fluorescence ability, oxidase and arginine dihydrolase activities, hypersensitivity reaction and ice nucleation ability were conducted to screen bacteria isolated from field and control samples. No bacteria were detected from field samples which matched the expected test profiles of genetically altered bacterial products. In contrast, bacteria were consistently isolated from positive control samples with the expected characteristics of genetically altered bacteria.

32283 (PIRSEM–3246) **Amorphous GaAs thin layers.** Carchano, R. Centre National de la Recherche Scientifique, 75 - Paris (France). Programme Interdisciplinaire de Recherche sur les Sciences pour l'Energie et les Matiernes Premieres (PRISEM); Aix-Marseille-3 Univ., 13 - Marseille (France). Sep 1987. 156p. (In French). Order Number DE90790631. Available from NTIS (US Sales Only), PC A08/MF A01.

The objective of the study was to improve the GaAs material in order to develop a Schottky type device. The effects of various deposit parameters and substrate temperature on the structural properties of the thin film are examined. The optical and electrical properties of the material and their evolution with the substrate temperature are described. Results concerning the localized state densities in the forbidden band are presented and related to a doping operation.

32284 (SAND–89-7045) **Development of a point-contact solar cell using high-volume processing techniques: Final report.** Miner, G.E.; Christel, L.A.; Merchant, J.T.; Olson, J.S. Sandia National Labs., Albuquerque, NM (USA); SERA Solar Corp., Santa Clara, CA (USA). Apr 1990. 63p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. Order Number DE90010330. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Point-contact solar cells have achieved the highest efficiencies recorded to date for silicon cells, reaching 28.2% at 10 watts/cm^2. Though this technology offers several advantages over conventional bifacial cells, special process techniques are needed to optimize performance. Point-contact cells require a thin base, high bulk lifetime, low surface recombination velocities, effective light trapping, and effective heat sinking. These requirements were addressed in the development of a high-efficiency cell process using high-volume, integrated-circuit process equipment. Two methods developed for producing thin cells were compared in yield and manufacturability. Techniques were developed for processing thin cells using automated production equipment. The fabrication process was designed to minimize lifetime degradation. Minority carrier lifetime data are presented for a full range of process steps. Three optical textures were compared in an experimental light-trapping study. These process techniques were combined to produce several types of cells. The best has achieved an efficiency of 25.0% at 87 suns. 23 refs., 16 figs., 7 tabs.

32285 **The manganese site of the photosynthetic water-splitting enzyme.** George, G.N. (Exxon Research and Engineering Co., Annandale, NJ (USA)); Prince, R.; Cramer, S.P. *Science (Washington, D.C.) (USA),* 243(4892): 789-791 (10 Feb 1989).

As the originator of the oxygen in our atmosphere, the photosynthetic water-splitting enzyme of chloroplasts is vital for aerobic life on the earth. It has a manganese cluster at its active site, but it is poorly understood at the molecular level. Polarized synchrotron radiation was used to examine the x-ray absorption of manganese in oriented chloroplasts. The manganese site, in the resting (S_1) state, is an asymmetric cluster, which probably contains four manganese atoms, with interatomic separations of 2.7 and 3.3 angstroms; the vector formed by the 3.3-angstrom manganese pair is oriented perpendicular to the membrane plane. Comparisons with model compounds suggest that the cluster contains bridging oxide or hydroxide ligands connecting the manganese atoms, perhaps with carboxylate bridges connecting the 3.3-angstrom manganese pair. 24 refs., 2 figs., 1 tab.

32286 **Water oxidation in photosystem II: From radical chemistry to multielectron chemistry.** Babcock, G.T. (Michigan State Univ., East Lansing (USA)); Barry, B.A.; Debus, R.J.; Hoganson, C.W.; Atamian, M.; McIntosh, L.; Sithole, I.; Yocum, C.F. *Biochemistry (USA),* 28(25): 9557-9565 (12 Dec 1989).

This review article describes the progress that has been made in understanding the photosystem II/oxygen-evolving complex (PSII/OEC). Photosystem II forms the photochemical core of the system: upon light absorption PSII generates oxidizing equivalents or holes at sufficiently high potential to oxidize water. The OEC can exist in five redox states depending on the number of stored oxidizing equivalents. These redox states are designated S_0-S_4, with S_4 being the most oxidizing and capable of oxidizing water. The rapid progress in researching this important membrane protein has been due to several factors. First, oxygen evolution has proven to be quite stable to biochemical manipulation. Second, the crystallization of the bacterial reaction center, the realization of the analogies between it and PSII, and the demonstration of the relevance of constructing experiments on the basis of the analogy have provided a shortcut to dissecting the oxygen-evolving system. Finally, because the water-splitting process, like all photosynthetic reactions, can be initiated by light, kinetic studies over the picosecond to second time regime have become possible. The majority of the current work is aimed at determining the structure of the complex.

32287 **Isolation of a photoactive photosynthetic reaction center - core antenna complex from Heliobacillus mobilis.** Trost, J.T. (Arizona State Univ., Tempe (USA)); Blankenship, R.E. *Biochemistry (USA),* 28(26): 9898-9904 (26 Dec 1989).

A photoactive reaction center-core antenna complex was isolated from the photosynthetic bacterium Heliobacillus mobilis by extraction of membranes with Deriphat 160c followed by differential centrifugation and sucrose density gradient ultracentrifugation. The purified complex contained a M_r 47000 polypeptide(s) that bound both the primary donor (P800) and approximately 24 antenna bacteriochlorophylls g. Time-resolved fluorescence emission spectroscopy indicated that the antenna bacteriochlorophylls g are active in energy transfer to P800, exhibiting a decay time of 25 ps. The complex contained 1.4 menaquinones, 9 Fe, and 3 labile S^{2-} per P800. The complex was photoactive with an exponential decay time of 14 ms for $P800^+$ yet showed no EPR-detectable Fe-S center signal in the $g \leq 2.0$ region, either by chemical reduction to -600 mV or by illumination of reduced samples. The complex is similar to photosystem I or oxygen-evolving photosynthetic systems in that both the primary donor and a core antenna are bound to the same pigment-protein complex.

1406 Photovoltaic Power Systems

Refer also to citation(s) 32263

32288 (AFME–83.1175) **Solar powered pumping systems. Existing material, cost of a cubic meter, comparison with other pumping systems, maintenance, appendix.** Billerey, J. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). Dec 1986. 120p. (In French). Order Number DE90790628. Available from NTIS (US Sales Only), PC A06/MF A01.

The various technical solutions for solar powered pumping are presented and their feasibility examined: long shaft pumps, submerged motor pumps with DC, AC and electronic motors, and surface pumps. The equipment costs, installation, drilling costs, etc. are evaluated and an economic evaluation of the photovoltaic pumping is performed with comparison to wind energy or thermal engine pumping.

1407 Solar Thermal Power Systems

32289 (PWC/SPO–CE02985) **Architectural and technical concerns pertaining to the design and operation of solar heating installations.** Programme d'achat et d'utilisation de materiel de chauffage solaire, Comite interministeriel d'execution des programmes 16 Octobre [1979], Document no.4. Public Works Canada, Ottawa, ON (Canada). Solar Programs Office. [1979]. 61p. (CE–02985). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This document is a translation into French of 2 reports destined to the general public and written for the US Department of Energy (DOE), which are of use for the design and evaluation of solar heating projects. The first report is about architectural considerations, and deals with the physical and economical aspects of various solutions in view of the DOE's experience with the US manufacturers. The second report is about the start-up and operation of solar heating installation in relation with their design. Separate abstract have been prepared for both reports. 108 figs.

32290 (SAND–89-3086C) **A direct absorber reactor/receiver for solar thermal applications.** Hogan, R.E. Jr. (Sandia National Labs., Albuquerque, NM (USA)); Skocypec, R.D.; Diver, R.B.; Fish, J.D.; Garrait, M.; Richardson, J.T. Sandia National Labs., Albuquerque, NM (USA). [1990]. 19p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. (CONF-900703–1: 11. international symposium on chemical reaction engineering (ISCRE '11), Toronto (Canada), 8-11 Jul 1990). Order Number DE90006280. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A novel catalytic reactor concept is described in which concentrated radiant (solar) energy is directly absorbed at the catalytic reaction sites, thereby avoiding the heat-transfer limitations of conventional tubular reactors for high-flux conditions. Results from a detailed numerical model of a direct catalytic absorption reactor illustrate unique features of the reactor and critical design requirements of the volumetric absorber. Numerical predictions compare

well with preliminary experimental data for carbon dioxide reforming of methane to synthesis gas. Thermal and chemical conditions of the absorber for a large-scale reactor under typical high-flux operation are shown. 11 refs., 7 figs., 2 tabs.

1409 Solar Thermal Utilization

Refer also to citation(s) 32479, 32483, 32489

32291 (Bouwcentrum–11786) **Passive use of solar energy in the public housing of Capelle aan den IJssel, Netherlands: Evaluation and final report.** Schrama, J.T.A.; De Vries, G.; Straatman, J.T.H. Bouwcentrum, Rotterdam (Netherlands). Sep 1987. 93p. (In Dutch). Order Number DE90786186. Available from NTIS (US Sales Only), PC A05/MF A01.

Eleven houses in Capelle aan den IJssel, Netherlands, have been built for a test project to study the passive use of solar energy for space heating. Two houses are equipped with a facade collector to preheat ventilation air, three houses are extended with a parlor to preheat the ventilation air, all houses use solar water boilers and air heating systems. The preparation of the project and the final design, the building of the houses and the measurements are described elsewhere in detail. This report summarizes and evaluates the different phases of the project: project description and goals, construction of the test houses, results of the measurements (energy yields, energy consumption), problems during the project, different costs, cost benefit analysis, projects with regard to the system, housing construction and the industry. 30 figs., 7 refs., 14 tabs., 7 apps.

1410 Solar Collectors and Concentrators

32292 **Direct-contact heat transfer processes.** Boehm, R.F. (Univ. of Utah, Salt Lake City, UT (US)); Kreith, F. 1-24 of Direct-contact heat transfer. Kreith, F.; Boehm, R.F. Hemisphere Publishing, New York, NY (USA) (1988).

A key challenge in the design of efficient energy conversion systems is to achieve effective heat transfer at temperatures that can extract the minimum thermodynamic potential of the system's heat source. In classical heat exchangers, heat transfer takes place through a wall separating the hot and the cold fluid streams. Thus, conventional heat exchangers are limited in their ability to tab the maximum thermodynamic potential because they have built-in thermal losses associated with the separation of the fluid streams by an intervening solid wall. A problem facing the engineer who wants to use direct-contact heat transfer is the limited general understanding of the processes and a lack of a reliable methodology for predicting the thermodynamic performance. Current practice usually relies on empirical correlations for a given geometry that are difficult, if not impossible, to transfer to another geometric configuration. Except for some limited use of mass transfer data to predict heat transfer characteristics by means of the analogy between heat and mass transfer, there exist no generalized approaches to predict the performance of direct-contact heat transfer devices similar to the LMTD or effectiveness-NTU method in closed heat exchangers. A few examples of direct-contact heat transfer applications are presented to illustrate the situation.

1420 Heat Storage

32293 (DTH-LV-MEDD–190) **Simulation of thermal conditions in a solar heating system with seasonal storage.** Berg, P. Danmarks Tekniske Hoejskole, Lyngby (Denmark). Lab. for Varmeisolering. Mar 1988. 193p. (In Danish). Order Number DE90791294. Available from NTIS (US Sales Only), PC A09/MF A01.

Ideas for calculation of isolines using input data given in either a regular, or an irregular, net have been tested. A numerical model for a solar energy system consisting of a smaller ground storage, a solar collector and a heat pump has been developed. The use of pit storage as a seasonal heat storage in central solar heating systems was analyzed. A simplified model of a pit storage and the surrounding soil was developed. The model was extended to include all components in a central solar heating system. These components consist of a solar collector field, pipelines, heat exchangers, a back-up unit and a heat distribution system. A new approach allows transient simulation of solar collectors under low flow conditions. The model was used as design basis for a planned solar heating system with an expected energy output of 1.9 TJ/hear, a design storage volume of 4000 m3 and a collector area of 1000 m2. Based on several simulations and cost estimates for construction, operation and depreciation, optimal thicknesses and shapes of the pit insulation were calculated. These were found to be 0.5 m for the top insulation (k = 0.05 W/m deg. C) and 0.25 m for a vertical side insulation (k = 0.05 W/m deg. C) extended downwards to 2/3 of the depth of the pit. Vertical insulation should be placed as close as possible to the edge of the pit. A second investigation estimated optimal rations between the storage volume and the collector area, resulting in a minimum investment for a given yearly solar coverage. For a yearly solar coverage of 75%, the minimum investment was found at a storage voluem of 4000 m3 and a collector area of 1850 m2. The insulation thicknesses mentioned above should be increased by 35% in this design. The energy cost at the optimal design was finally estimated to DKK 0.52/kWh. (AB).

1440 Legislation and Regulations

Refer also to citation(s) 32524

15 GEOTHERMAL ENERGY

1501 Resources and Availability

32294 (PIRSEM–0253-1) **Experimental determination of the flow speed of the Dogger geothermal aquifer in the Paris basin.** Marsily, L. de. Centre National de la Recherche Scientifique, 75 - Paris (France). Programme Interdisciplinaire de Recherche sur les Sciences pour l'Energie et les Matiernes Premieres (PRISEM). 1986. 267p. (In French). Order Number DE90790624. Available from NTIS (US Sales Only), PC A12/MF A01.

The aquifer flow speed is measured through two methods: one based on the in situ dilution of a radioactive tracer in the well with time, the other on the permeability and the pressure gradients measured at the bottom of the well. The main conclusion is that it is no longer possible to consider the natural velocity in this aquifer as negligible. Such a velocity has a significant effect on the life span of a geothermal doublet, especially if the orientation of the doublet is not favourable with respect to that of the aquifer flow.

1502 Geology and Hydrology of Geothermal Systems

32295 (DOE/ID/12756–1) **The Newcastle geothermal system, Iron County, Utah: Geology, hydrology, and conceptual model, Volume 1: Final report.** Blackett, R.E. (Utah Geological and Mineral Survey, Salt Lake City, UT (USA)); Shubat, M.A.; Bishop, C.E.; Chapman, D.S.; Forster, C.B.; Schlinger, C.M. Utah Geological and Mineral Survey, Salt Lake City, UT (USA). Mar 1990. 84p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG07-88ID12756. Order Number DE90010574. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Geological, geophysical and geochemical studies contributed to conceptual hydrologic model of the "blind" (no surface expression), moderate-temperature (greater than 130°C) Newcastle geothermal system, located in the Basin and Range-Colorado Plateau transition zone of southwestern Utah. Temperature gradient measurements define a thermal anomaly centered near the surface trace of the range-bounding Antelope Range fault with and elongate dissipative plume extending north into the adjacent Escalante Valley. Spontaneous potential and resistivity surveys sharply define the geometry of the dominant upflow zone (not yet explored), indicating that most of the thermal fluid issues form a short segment along the Antelope Range fault and discharges into a gently-dipping aquifer. Production wells show that this aquifer lies at a depth between 85 and 95 meter. Electrical surveys also show that some leakage of

thermal fluid occurs over a 1.5 km (minimum) interval along the trace of the Antelope Range fault. Major element, oxygen and hydrogen isotopic analyses of water samples indicate that the thermal fluid is a mixture of meteoric water derived from recharge areas in the Pine Valley Mountains and cold, shallow groundwater. A northwest-southeast trending system of faults, encompassing a zone of increased fracture permeability, collects meteoric water from the recharge area, allows circulation to a depth of 3 to 5 kilometers, and intersects the northeast-striking Antelope Range fault. We postulate that mineral precipitates form a seal along the Antelope Range fault, preventing the discharge of thermal fluids into basin-fill sediments at depth, and allowing heated fluid to approach the surface. Eventually, continued mineral deposition could result in the development of hot springs at the ground surface.

1503 Geothermal Exploration and Exploration Technology

32296 (ETSU-G–137F) **Camborne geothermal energy project 2C-5. Final report Phase 2C: October 1986 - September 1988.** Parker, R.H. Camborne School of Mines (UK). Geothermal Energy Project; Department of Energy, London (UK); UKAEA Harwell Lab. (UK). Energy Technology Div. 1989. 165p. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

The work carried out in Phase 2C of the Camborne School of Mines Geothermal Energy Project is reported. The programme of circulation of the reservoir at Rosemanowes can be divided into three stages: a gradual step-wise increase in injection flow rate to a level of 35 1/s; the use of downhole pump to lower the pressure in the main production well to simulate the sub-hydrostatic conditions which are expected in a 6 km-deep production well; and finally, a long period of constant injection flow rate (21.5 1/s), during which a flow path characterisation experiment was carried out. Techniques of characterising this reservoir were further developed. (author).

32297 (UCRL–100841) **Seismic imaging for velocity and attenuation structure in geothermal fields.** Zucca, J.J. (Lawrence Livermore National Lab., CA (USA)); Evans, J.R. Lawrence Livermore National Lab., CA (USA). Jun 1989. 5p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-7405-ENG-48. (CONF-891031–11: Annual meeting of the Geothermal Resources Council: the geysers - three decades of achievement: a window on the future, Santa Rosa, CA (USA), 1-4 Oct 1989). Order Number DE90010742. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We have applied the attenuation inversion technique developed by Evans and Zucca (1988) to a seismic tomographic data set taken at Newberry Volcano by Achauer et al. (1988). Our preliminary results suggest that the interpretation of the velocity data by Achauer et al. that a magma chamber is present 3 km beneath the caldera is not confirmed by the attenuation data.

1506 Environmental Aspects

Refer also to citation(s) 33164

1509 Geothermal Engineering

Refer also to citation(s) 32296, 33261

32298 (EGG-EP–9029) **FRAC-UNIX theory and user's manual.** Clemo, T.M.; Miller, J.D.; Hull, L.C.; Magnuson, S.O. EG and G Idaho, Inc., Idaho Falls, ID (USA). May 1990. 258p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC07-76ID01570. Order Number DE90010915. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

The FRAC-UNIX computer code provides a two-dimensional simulation of saturated flow and transport in a fractured porous media. The code incorporates a dual permeability approach in which the rock matrix is modeled as rectangular cells and the fractures are represented as discrete elements on the edges and diagonals of the matrix cells. A single head distribution drives otherwise independent flows in the matrix and in the fractures. Steady-state or transient flow of a single-phase fluid may be simulated. Solute or heat transport is simulated by moving imaginary marker particles in the velocity field established by the flow model, under the additional influence of dispersive and diffusive processes. Sparse-matrix techniques are utilized along with a specially developed user interface. The code is installed a CRAY XMP24 Computer using the UNICOS operating system. The initial version of this code, entitled FRACSL, incorporated the same flow and transport models, but used a commercial software package for the numerics and user interface. This report describes the theoretical basis, approach and implementation incorporated in the code; the mechanics of operating the code; several sample problems; and the integration of code development with physical modeling and field testing. The code is fully functional, for most purposes, as shown by the results of an extensive code verification effort. Work remaining consists of refining and adding capabilities needed for several of the code verification problems; relatively simple modifications to extend its application and improve its ease of use; an improvement in the treatment of fracture junctions and correction of an error in calculating buoyancy and concentration for diagonal fractures on a rectangular grid. 42 refs., 28 figs., 5 tabs.

32299 (SAND–90-1075C) **Lost circulation technology development projects.** Glowka, D.A. Sandia National Labs., Albuquerque, NM (USA). [1990]. 21p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. (CONF-9004131–1: The national energy strategy–the role of geothermal technology development, San Francisco, CA (USA), 18-20 Apr 1990). Order Number DE90009742. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Lost circulation is the phenomenon where circulating drilling fluid is lost to fractures or pores in the rock formation rather than returning to the surface through the wellbore annulus. In geothermal drilling, lost circulation can be a serious problem that contributes greatly to the cost of the average geothermal well. A DOE-sponsored program is underway at Sandia National Laboratories to develop new technology for solving lost circulation problems. The Lost Circulation Technology Development Program currently consists of twelve projects in three areas: technology to plug porous and minor-fracture loss zones; technology to plug major-fracture loss zones; and technology to characterize loss zones. This paper describes the program and highlights recent progress. 12 refs., 10 figs.

32300 Design and evaluation of lost-circulation materials for severe environments. Loeppke, G.E. (Sandia National Labs., Albuquerque, NM (USA)); Glowka, D.A.; Wright, E.K. *Journal of Petroleum Technology (USA)*, 42(3): 328-337 (Mar 1990).

As part of the U.S. DOE's Geothermal Technology Development Program Sandia Natl. Laboratories conducted an extensive testing program to evaluate candidate LCM's to aid in solving the severe lost-circulation problems encountered in geothermal-well drilling. This work concentrated on high-temperature, fracture-dominated loss zones rather than the matrix loss zones more typical of oil and gas drilling. The results, however, are applicable to the petroleum industry, particularly because of the inevitable progression into hotter, more fracture-dominated petroleum reservoirs. The lost circulation materials (LCM's) for geothermal applications were analyzed with laboratory tools developed specifically for that purpose. Test results of commercial materials and mathematical models for evaluating their performance are presented. Physical attributes that govern the performance of LCM's in geothermal wells are identified and correlated with test results.

17 WIND ENERGY

Refer also to citation(s) 32472

1701 Resources and Availability (Climatology)

32301 (AFME–85.06.1017) **Wind potential energy determination at Cammazes site.** Flori, J.P.; Duchene-Marullaz, P. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris

(France). Jun 1986. 18p. (In French). Order Number DE90790626. Available from NTIS (US Sales Only), PC A03/MF A01.

Wind speed and direction data were measured on the complex topographic site of Cammazes (France). The data were then correlated to the speed and direction data from the meteorological station of Carcassonne. The potential wind energy and the annual energy output from a Ratier-Figeac wind turbine are calculated.

1706 Wind Energy Engineering

32302 (DMI–89836-Vol.1) **Wind turbine wake interference. A validation study. Vol. 1: Main text.** Larsen, A.; Oort, H. van. Skibsteknisk Laboratorium, Lyngby (Denmark). May 1989. 42p. Contract EN3W-0008-DK. Order Number DE90791320. Available from NTIS (US Sales Only), PC A03/MF A01.

The Danish Maritime Institute, Denmark and MT-TNO, the Netherlands have concluded an extensive research project comprising full-scale measurements and sample calculations in the Taendpipe Windfarm situated on the Danish west coast. The research project was financially supported partly by the Commission of the European Communities and partly by national funds. The objectives of the project were to acquire information on the following topics: - The wind field within a large Windfarm. - Wake effects on the power performance of individual turbines in a large windfarm. - Wake effects on the total power output of a large windfarm. The full-scale data acquired during the measurement campain was to be used for validation of available prediction schemes for: - Power performance and wind fields in windfarms. Kinematic model FARMS. - Wake properties of single wind turbines, Eddy-viscosity model EVMOD. During the measurement period (approximately 24 weeks) a full-scale data set was acquired which allowed properties of wind turbine wakes and the power performance of individual turbines and the complete windfarm to be assessed with good accuracy. Comparison of measured and predicted wind fields in the Taendpipe Windfarm demonstrates that the kinematic FARMS model predicts multiple with turbine wakes with good accuracy. Power predictions are found to be less accurate probably due to significant differences in the measured power performance curves for the individual wind turbines. The accuracy of the power predictions performed is still considered to be fair, however, as the scatter between measured and predicted power output lie within the standard deviation of the measurements for most of the conditions analysed. Prediction of single wake profiles by means of the Eddy-viscosity model EVMOD is found to agree well with measurements as the width and depth of measured single wake profiles is calculated with good accuracy. (author).

32303 (DMI–89836-Vol.2) **Wind turbine wake interference. A validation study. Vol. 2: Measurement results.** Larsen, A.; Oort, H. van. Naturgas Sjaelland I/S, Soroe (Denmark). May 1989. 136p. Contract EN/3W-0008-DK. Order Number DE90791322. Available from NTIS (US Sales Only), PC A07/MF A01.

Measurement results in relation to performance testing and prediction of energy yields of wind turbine arrays. Emphasis is laid on the effects of wake interference. (AB).

32304 (ECN-RX–90-003) **Accuracy of wind measurements and international intercalibration of anemometers.** Curvers, A.; Schuurman, J.J. Netherlands Energy Research Foundation, Petten (Netherlands). Feb 1990. 7p. (In Dutch). Order Number DE90786127. Available from NTIS (US Sales Only), PC A02/MF A01.

Within the framework of the Joint European Test Site Activities, supported by the European Commision in Brussels, two projects are carried out in which measuring wind speed is an important factor. In the Anemometry-project the accuracy in measuring the wind speed has been determined. Next recommendations are made with regard to requirements which have to be set to cup anemometers and their applications. These recommendations have been used in formulating a European Standard for the measurement of wind turbine power curves, the second project. Also demands were set to the test site to minimize the uncertainties in the measured wind speed which result from coherence problems and obstacle effects. An international intercalibration of anemometers however shows warrisome results which stand in the way to an international standardization for anemometers and mutual recognition of measured wind turbine power curves. 1 fig., 2 tabs., 14 refs.

32305 (SERI/TP–257-3455) **Wake deficit measurements on the Jess and Souza Ranches, Altamont Pass.** Nierenburg, R. (Altamont Energy Corp., San Rafael, CA (USA)). Solar Energy Research Inst., Golden, CO (USA); Altamont Energy Corp., San Rafael, CA (USA). Apr 1990. 145p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE89009505. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

This report is ninth in a series of documents presenting the findings of field test under DOE's Cooperative Field Test Program (CFTP) with the wind industry. This report provides results of a project conducted by Altamont Energy Corp. (AEC) to measure wake deficits on the Jess and Sousa Ranches in Altamont Pass, CA. This research enhances and complements other DOE-funded projects to refine estimates of wind turbine array effects. This project will help explain turbine performance variability caused by wake effects. 4 refs., 28 figs., 106 tabs.

32306 (SERI/TP–257-3695) **Aerodynamic pressure measurements on a rotating wind turbine blade.** Butterfield, C.P.; Jenks, M.D.; Simms, D.A.; Musial, W.P. Solar Energy Research Inst., Golden, CO (USA). May 1990. 10p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. (CONF-900599–6: 36. Instrument Society of America international instrumentation symposium, Denver, CO (USA), 6-10 May 1990). Order Number DE90000327. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A microprocessor-controlled measurement system has been designed and built to make accurate measurements of low pressures on a rotating wind turbine blade. This Pressure System Controller (PSC) is capable of simultaneously operating four pressure scanners (128 channels total) while rotating on a wind turbine blade. Calibrations and purge sequences are performed automatically on all 128 channels while the turbine is rotating. Data are fed to a Pulse Code Modulation (PCM) data-acquisition system and recorded on magnetic tape for later processing. Accurate measurements have been made down to pressures of 11 microbars (0.00018 psi) for low Reynolds Number tests. These rotating-blade pressure measurements are used to compare with wind tunnel data to see how blade rotation alters airfoil performance. A description of the test setup and instrumentation design is given along with examples results. Recommendations for future work and changes in the design approach are also discussed. 7 refs., 13 figs.

32307 (SL–1271-87828) **Measurements at Aeroe Windmill park.** Jensen, A.G. Skibsteknisk Laboratorium, Lyngby (Denmark). Mar 1988. 113p. (In Danish). Contract TR-85.451.1. Order Number DE90791318. Available from NTIS (US Sales Only), PC A06/MF A01.

The aim of the measuring program carried out at the Aeroe Windmill park was to measure and analyse the effect of the "shadowing" of one or more windmills in relation to the other(s) with regard to individual wind loads, and to determine the statistics connected with the effect of the wind turbine array's power production on the public electric utility's network over a longer period of time. The shadowing effect was based on the wind turbine's calculated yield which is also connected to the individual wind turbine's efficiency curve. Measurement as complicated by the uneven terrain. Some differences were caused by variations in the tip angle of the turbine blades. It was discovered that there was a relation between the effect of the shadowing and the breadth of the obstruction caused in relation to wind load. The measured efficiency reduction was shown to be double as much as the calculated efficiency without shadowing, and it is recommended that shadowing effects are significant enough to be reckoned with when calculating the efficiency of wind turbines. (AB).

32308 (SSSU–38) **Two-dimensional wind tunnel tests of the SSS Series 1 structurally efficient aerofoils for wind turbines.** Turnock, S.R. Southampton Univ. (UK). Dept. of Ship

Science. Jun 1989. 136p. Contract CEC EN3 W-0016-UK. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

The two-dimensional lift, drag, and quarter chord moment coefficients were measured for the new design Southampton Ship Science series 1 aerofoils for angles of attack between a minimum of -6^0 and a maximum of 21^0. Five of the new series aerofoils were tested with thickness-chord ratio varying in 2% increments between 21% and 29%. An LS(1) 0421 mod aerofoil was also tested. All six aerofoils had a 610mm chord and an overall span of 995mm. The aerofoils were tested over a three week period using a two-dimensional test rig designed for use in the Southampton University 11' x 8' working section closed return low speed wind tunnel. A detailed description of the design, operation and installation of this test rig forms the main part of this report. The aerodynamic forces and moments were measured on the central 595mm span of the aerofoil using two three-component strain gauge balances. A wake traverse mechanism 0.5 chord downstream of the aerofoil trailing edge was used to obtain a further drag measurement. Results for each aerofoil are presented in the form of Lift-Incidence, Drag-Lift, and Moment-Lift polars. Tests were conducted at a chord Reynolds number of 1600000 and 2000000. Measurements with a roughness strip applied at 5% chord from the leading edge was also obtained. (author).

20 FOSSIL-FUELED POWER PLANTS

2001 Power Plants and Power Generation

Refer also to citation(s) 32120, 32490, 32513

32309 (DOE/EA–0396) **Utility retrofit demonstration using TRW slagging combustor technology: Environmental Assessment.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); TRW Energy Products Group. Redondo Beach, CA (USA). Combustion Business Unit. Feb 1990. 119p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90010561. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This Environmental Assessment (EA) describes a proposed CCT project that is designed to demonstrate the use of slagging combustion technology for the control of sulfur dioxide (SO_2) and nitrogen oxides (NO_x) at coal fired electric power plants. Slagging combustion technology has the potential to allow a plant to burn a higher sulfur content coal without an increase in SO_2 emissions. TRW has developed a slagging combustion system (SCS) which can be attached directly to a boiler. This technology consists of a staged combustion system to prevent excessive NO_x formation, sorbent injection to remove SO_2, and a centrifugal action in the slagging stage to remove the bulk of the ash from the combustion products before they enter the boiler. With solids removed from the combustion products, the combustor can be retrofitted to gas- or oil-fired boilers. The demonstration project is divided into two phases. The first phase involves retrofit activities on the power plant. The second phase involves a 6-month test program to demonstrate the ability of the TRW combustor system to meet both New York SIP and NSPS emission requirements. Low and medium sulfur coal will be tested. This report describes the actions to be taken at Lovett Station and the environmental impacts of those actions. Section 2.0 provides a comprehensive description of the proposed action, characterizes project source terms, and discusses environmental alternatives. Section 3.0 characterizes the existing environment, while Section 4.0 characterizes the potential impacts. Section 5.0 provides a brief review of regulatory compliance associated with this project. 6 figs., 25 tabs.

2002 Waste Management

Refer also to citation(s) 32081, 32095, 32096, 32309, 32513

32310 (DOE/MC/10637–2827-Task-2.1) **Simultaneous SO_x/NO_x control: Technical report, April 1, 1987–March 31, 1988 including Quarterly technical progress report, January–March 1988.** Weber, G.F.; Collings, M.E.; Schelkoph, G.L. North Dakota Univ., Grand Forks, ND (USA). Energy and Mineral Research Center. May 1988. 51p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-86MC10637. Order Number DE90011404. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The overall project objective is to expand the scientific and engineering data base necessary for the development of innovative processes for the control of SO_x emissions during coal combustion. Investigation of dry sorbent injection concepts for SO_x control and methods of enhancing SO_x sorbent reactivity/utilization were considered in this project. Task A, Sorbent Evaluation, activities in the second year of the Cooperative Agreement involved evaluation of two limestones and their respective calcination and hydration products. Pilot-scale furnace injection experiments and chemical and physical analysis were performed on the commercial sorbents to establish baseline characteristics. Task B, Enhanced Sorbent Reactivity/Utilization, activities involved the evaluation of additives to improve the reactivity/utilization of calcium-based hydrates. Six additives were evaluated during a series of tests involving the preparation of both atmospheric and pressure hydrates. Commercial Marblehead lime was used as the base sorbent. The additives included 10% aqueous solutions (by weight) of NaOH, $NaHCO_3$, $NaSiO_3$, $CaCl_2$, and acetic acid, and a 25% solution of ethanol. Task C, Combustion System Operability, involved activities evaluating the impact of furnace injection on ash deposition, electrostatic precipitator performance, and baghouse performance. Pilot-scale combustion tests were conducted with a Monticello, Texas, lignite/Round Rock pressure hydrate fuel/sorbent combination and a Pittsburgh No. 8/Mercer pressure hydrate fuel/sorbent combination. 25 refs., 19 figs., 17 tabs.

32311 (DOE/PC/91022–T5) **Acoustic agglomeration of power plant fly ash for environmental and hot gas cleanup: Final report: Revised Version.** Reethof, G.; Koopmann, G.H. Pennsylvania State Univ., University Park, PA (USA). Dec 1989. 503p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-86PC91022. Order Number DE90008251. Available from NTIS, PC A22/MF A01 - OSTI.

This two year research program has the objectives of completing the several investigations associated with the use of high intensity acoustic energy to agglomerate micron and submicron sized particles in fly ash aerosols in order to provide the necessary scientific knowledge and design criteria for the specification of technically and economically viable intermediate flue gas treatment of coal fired power plants. Goals are to further the understanding of certain fundamental processes by means of theoretical and experimental investigations to include this knowledge in an advanced computerized model of the agglomeration processes. Tests with the acoustic agglomeration facilities available in Penn State's new High Intensity Acoustic Laboratory were to be used to verify the results from the acoustic agglomeration simulations. Research work continued on high power, high efficiency sirens with special emphasis on the nonlinear acoustic phenomena and novel means of significantly increasing siren efficiency. A study was carried out to evaluate the economics of conventional coal fired power plant clean-up systems using acoustic agglomeration as an intermediate flue gas treatment. 154 refs., 152 figs., 30 tabs.

32312 (EPRI-GS–6281, pp. 1.1-1.9) **The importance of clean coal technologies to reduce power plant emissions.** Siegel, J.S. (Department of Energy, Washington, DC (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Writing Consultants Associated, Pittsburgh, PA (USA). Oct 1989. (CONF-8710500–: Seminar on reducing power plant emissions by controlling coal quality, Bethesda, MD (USA), 27-28 Oct 1987). In *Proceedings: Reducing power plant emissions by controlling coal quality.* Order Number DE90001365. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The Department of Energy's Clean Coal Technology (CCT) Program has been established to demonstrate the commercial feasibility of a new generation of emerging clean coal technologies that will provide a suite of techniques to suit the individuals user's needs. Innovative clean coal technologies can generally be grouped into two categories: (1) retrofit technologies which can be used on existing plants to reduce emissions, and (2) repowering technologies that replace all or a significant portion of the original

plant and often increase capacity while reducing emissions. Retrofit techniques such as advanced coal cleaning, limestone injection multistage burner (LIMB), slagging combustors, gas reburning, in-duct sorbent injection, coal-water mixtures and advanced flue gas cleanup, used separately or in combination, can control both SO_2 and NO_X. The purpose of this address is to give a sense of what this country stands to gain from the use of coal and from a coal technology program, both at the demonstration and R&D level.

32313 (EPRI-GS-6281, pp. 12.1-12.7) **Estimated reductions in SO_2 emissions from the 100 largest electric utility power plant emitters through coal cleaning.** Hoffman, L. (Science Applications International, McLean, VA (USA)); Hensel, D.S.; Feeley, T.J. III. Electric Power Research Inst., Palo Alto, CA (USA); Writing Consultants Associated, Pittsburgh, PA (USA). Oct 1989. (CONF-8710500--: Seminar on reducing power plant emissions by controlling coal quality, Bethesda, MD (USA), 27-28 Oct 1987). In *Proceedings: Reducing power plant emissions by controlling coal quality.* Order Number DE90001365. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This paper is an updated overview of an assessment of the reduction of sulfur dioxide (SO_2) emissions that could be achieved through increased physical cleaning. The assessment is based on the coal burned in 1986 by the largest SO_2-emitting electric utility power plants. Estimates of SO_2 reductions are presented for three levels of conventional coal cleaning and for advanced coal-cleaning processes. The SO_2 reductions are based on removing more of the pyritic sulfur from the coal burned than that removed by current coal-cleaning practices. The results indicate that the extensive application of advanced coal cleaning could result in a significant reduction in SO_2 emissions.

32314 (EPRI-GS-6307-Vol.1, pp. 4.249-4.263) **Simultaneous NO_x/SO_2 removal with dry sorbent injection.** Teague, M.E. (Fossil Energy Research Corp., Laguna Hills, CA (USA)); Thompson, R.E.; Muzio, L.J. Electric Power Research Inst., Palo Alto, CA (USA); Radian Corp., Research Triangle Park, NC (USA). Apr 1989. (CONF-881028--Vol.1: 1. combined flue gas desulfurization and dry SO_2 control symposium, St. Louis, MO (USA), 25-28 Oct 1988). In *Proceedings: First combined flue gas desulfurization and dry SO_2 control symposium.* Order Number DE89010757. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Dry SO_2 removal processes using calcium hydroxide have yielded nominally 40-60 percent SO_2 removal at Ca/S ratios of 2. Efforts to increase SO_2 removal and calcium utilization by modifying hydrate properties have met with only marginal success. However, instead of directly increasing SO_2 removal and calcium utilization, the attractiveness of dry SO_2 removal processes may also be enhanced if NO_x could be removed along with SO_2 using a single dry sorbent. To increase the cost-effectiveness of this process, a modified hydrate was developed that simultaneously removes SO_2 and NO_x. Pilot-scale results of injecting this single dry powder into a furnace are presented to characterize the SO_2 and NO_x removal characteristics, and a preliminary economic analysis of this process is developed. Initial pilot-scale results indicate that the dry sorbent is capable of simultaneous SO_2 and NO_x removals of 50 percent at Ca/S=2 and urea/NO_x=0.5. Higher SO_2 and NO_x removals can be achieved by changing the Ca/S and/or urea/NO_x ratios. The simplicity of the process is an important factor as it potentially offers an inexpensive approach for retrofit applications where both SO_2 and NO_x can be removed with minimum capital expenditures.

32315 (PB-90-169004/XAB) **Development of operation support system for flue-gas desulfurization plant.** Kouno, S.; Sakamoto, R.; Tatani, A.; Ohishi, T.; Nonogaki, Y. Mitsubishi Heavy Industries Ltd., Tokyo (Japan). c 1989. 6p. Available from NTIS, PC A06/MF A01.

Text in Japanese; Pub. in Mitsubishi Juko Giho, Vol. 26, No. 5, 386-390(1989).

An operation support system exclusively for use in a flue gas desulfurization plant has been developed to help start and shutdown operations, optimize process status, and facilitate operation by unskilled operators. The system has three major functions; guidance for recovery from alarm conditions, guidance for start and shutdown operations, and guidance for better operaton. Test operation has conducted at Nakoso power staton, and the knowledge database has been proved to meet specific site condition.

32316 (PB-90-181322/XAB) **Three-stage combustion (reburning) on a full-scale operating boiler in the USSR. Final report, March 1988-January 1990.** LaFlesh, R.C.; Lewis, R.D.; Anderson, D.K. Combustion Engineering, Inc., Windsor, CT (USA). Feb 1990. 180p. Available from NTIS, PC A09/MF A01.

The report gives results of a program to complete the preliminary design of a three-stage combustion (reburn) system for nitrogen oxide (NOx) emissions control on an operating boiler in the U.S.S.R. The program to design the reburn system consisted of five tasks: visiting the Ladyzhinskaya host site to exchange design and operating information; translating Soviet documents into English; performing process calculations; conducting physical flow modeling; and developing a preliminary system design which included general arrangement drawings and furnace performance analyses. The overall preliminary reburn system design was presented to and accepted by Soviet representatives during a June 1989 meeting at the EPA's Air and Energy Engineering Research Laboratory in Research Triangle Park, NC. It appears that reburning would be a viable NOx reduction technology for the type of boiler represented by the host Ladyzhinskaya steam generating unit.

2005 Environmental Aspects

Refer also to citation(s) 32098, 32309, 33097, 33098, 33106, 33143, 33144

32317 (PB-90-171992/XAB) **Environmental review of Southern Maryland Electric Cooperative's proposed combustion-turbine generating facility at Chalk Point.** Peters, N.; Tomko, J.; Keating, R.; Corio, L.; Stern, M. Environmental Resources Management, Inc., Annapolis, MD (USA). Dec 1989. 144p. Available from NTIS, PC A07/MF A01.

The report provides an environmental assessment of a 70-100 MW gas turbine generating facility which the Southern Maryland Electric Cooperative, Inc. (SMECO) has proposed to construct on the site of Potomac Electric Power Company's (PEPCO) Chalk Point Generating Station. The facility, to be used as a peaking plant, will be SMECO's first generating station. Construction of the facility is expected to begin in March 1990, with completion scheduled for December 1990. Commercial operation is expected to begin prior to January 1, 1991. On the basis of the information available, no deficiencies have been identified which warrant finding the Chalk Point site unsuitable for construction of the proposed SMECO facility. Potential impacts from air emissions, ground water withdrawal, release of contaminants to ground water, noise emissions, discharge of effluent, and disturbance of the site were specifically examined. Recommendations for evaluations following construction are also provided.

2006 Economic, Industrial, and Business Aspects

Refer also to citation(s) 32097, 32121

32318 (CONF-9004133-3) **Technology choice in a least-cost expansion analysis framework: The impact of gas prices, planning horizon, and system characteristics.** Guziel, K.A.; South, D.W. Argonne National Lab., IL (USA). [1990]. 6p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. From American power conference; Chicago, IL (USA); 23-25 Apr 1990. Order Number DE90011145. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The current outlook for new capacity addition by electric utilities is uncertain and tenuous. Regardless of the amount, it is inevitable that new capacity will be needed in the 1990s and beyond. The fundamental question about the addition capacity requirements centers on technology choice and the factors influencing the decision process. We examined technology choices in 10 representative power pools with a dynamic optimization expansion model, the Wien Automatic System Planning (WASP) Package. These 10 power pools were determined to be representative on the basis of a cluster analysis conducted on all 26 power pools in

the United States. A least-cost expansion plan was determined for each power pool with three candidate technologies–natural gas combustion turbine (CT), natural gas combined cycle (NGCC), and integrated gasification combined cycle (IGCC)–three alternative gas price tracks, and two planning horizons between the years 1995 and 2020. This paper summarizes the analysis framework and presents results for Power Pool 1, the American Electric Power (AEP) service territory. 7 refs., 9 figs., 1 tab.

2007 Legislation and Regulations

Refer also to citation(s) 32097

21 NUCLEAR POWER PLANTS

2101 Power Reactors, Nonbreeding, Light-Water Moderated, Boiling Water Cooled

Refer also to citation(s) 32200, 32214, 32341, 32345, 32361, 32363, 32364, 32371, 32377, 32379, 32380, 32381, 32382, 32384, 32385, 32387, 32388, 32390, 32393, 32394, 32395, 32396, 32397, 32398, 32399, 32400, 32401, 32402, 32403, 32404, 32405, 32407, 32408, 32409, 32410, 32411, 32412, 32413, 32419, 32551, 32552, 32572, 32583

32319 (EGG-M–88444) **Thermal behavior of cohesive debris beds in a degraded nuclear reactor.** Kuan, P.; Golden, D.W. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 16p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-890819–27: ASME/AIChE national heat transfer conference, Philadelphia, PA (USA), 6-9 Aug 1989). Order Number DE90010934. Available from NTIS, PC A03/MF A01; OSTI; INIS.

During a severe core damage accident in a nuclear light water reactor, the process of melting and solidification of core material results in a cohesive debris bed. This paper determines (a) the initial equilibrium thickness of the lower crust of the bed, which serves as a receptacle for subsequently melted material, (b) the formation of the upper crust of the bed, which, together with the lower crust, forms the boundary of the bed, (c) the heatup of the interior of the bed, and (d) the erosion of the rusts by the enclosed material as the latter is heated above its melting point. The results show that the upper crust tends to be relatively thin and is likely to fail under stress, as it did during the TMI-2 accident. 3 refs., 2 figs.

32320 (JAERI-M–90-002) **Benchmarking of FEMAXI-IV code with fuel irradiation data in power reactors.** Uchida, Masaaki (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Saito, Hiroaki. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 33p. (In Japanese). Order Number DE90791145. Available from NTIS (US Sales Only), PC A03/MF A01.

To study the applicability of the fuel behavior analysis code FEMAXI-IV to power reactor fuels, the Reliability Proving Test in Fukushima BWR and the extended burnup fuel test in Zorita PWR were taken up as benchmarking problems. Calculations were made based only on the published data and the results were compared with the post-irradiation examination data. The results of calculation on the BWR fuel have shown generally good agreement with the measurement data on fuel rod deformation and fission gas release rate, demonstrating the applicability of the FEMAXI-IV CODE to BWR fuels with a burnup range up to 30 MWd/kg. The result of benchmarking on the PWR fuel has revealed a problem that some calculated parameters excessively responds to changes of design or operation conditions. Its primary reason is considered to be the very high burnup of the Zorita fuel (56 MWd/kg): some concepts obtained from low burnup fuel experiences, on which fuel behavior codes as FEMAXI-IV are based, are considered to lose effectiveness at high burnup. (author).

2102 Power Reactors, Nonbreeding, Light-Water Moderated, Nonboiling Water Cooled

Refer also to citation(s) 32200, 32214, 32319, 32320, 32329, 32341, 32345, 32346, 32356, 32359, 32361, 32364, 32366, 32369, 32370, 32372, 32373, 32374, 32377, 32378, 32379, 32381, 32383, 32387, 32388, 32389, 32391, 32392, 32393, 32394, 32395, 32396, 32397, 32398, 32399, 32400, 32401, 32402, 32403, 32405, 32406, 32407, 32409, 32410, 32411, 32412, 32413, 32414, 32415, 32422, 32551

32321 (CONF-900789–2) **Embrittlement of the Shippingport reactor neutron shield tank.** Chopra, O.K. (Argonne National Lab., IL (USA)); Shack, W.J.; Rosinski, S.T. Argonne National Lab., IL (USA). [1990]. 37p. Sponsored by Nuclear Regulatory Commission. DOE Contract W-31109-ENG-38. From ASME PVP conference; Nashville, TN (USA); 17-21 Jul 1990. Order Number DE90010464. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The irradiation embrittlement of the Shippingport neutron shield tank material (A212 Grade B steel) has been characterized. Irradiation increases the Charpy transition temperature (CTT) by 23–28°C (41–50°F) and decreases the upper shelf energy. The shift in CTT is not as severe as that observed in the HFIR surveillance specimens. However, the actual value of CTT is higher than that for the HFIR data and the toughness at service temperature is low. The increase in yield stress is 51 MPa (7.4 ksi), which is comparable to the HFIR data. The results also indicate that the material is weaker in the TL orientation than LT orientation. Some effects of the location across the thickness of the wall are also observed; CTT is slightly greater for the specimens from the inner region of the wall. The data agree well with results from high-flux test reactors. Annealing studies indicate complete recovery of embrittlement after a 2-h anneal at 400°C. Although the weld metal is significantly tougher than the base metal, the shifts in CTT are comparable. The weld metal shows a strong affect of location across the thickness of the wall; only the inner regions of the weld show embrittlement. 11 refs., 14 figs., 3 tabs.

32322 (NUREG–1399) **Technical Specifications, Comanche Peak Steam Electric Station, Unit 1 (Docket No. 50-445): Appendix "A" to License No. NPF-87.** Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation. Apr 1990. 355p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A16/MF A01 - GPO; OSTI; INIS.

The Technical Specifications for Comanche Peak Steam Electric Station, Unit 1 were prepared by the US Nuclear Regulatory Commission. They set forth the limits, operating conditions, and other requirements applicable to a nuclear reactor facility, as set forth in Section 50.36 of Title 10 of the Code of Federal Regulations Part 50, for the protection of the health and safety of the public.

2103 Power Reactors, Nonbreeding, Graphite Moderated

Refer also to citation(s) 32703

32323 (JAERI-M–89-222) **The conceptual design of High Temperature Engineering Test Reactor upgraded through utilizing Pebble-In-Block fuel (UHTTR).** Yamashita, Kiyonobu (Japan Atomic Energy Research Inst., Oarai, Ibaraki (Japan). Oarai Research Establishment); Fumizawa, Motoo; Ishihara, Masahiro. Japan Atomic Energy Research Inst., Tokyo (Japan). Jan 1990. 78p. (In Japanese). Order Number DE90791083. Available from NTIS (US Sales Only), PC A05/MF A01.

This report presents the conceptual design study of future High Temperature Engineering Test Reactor upgraded through utilizing Pebble-in-Block fuel (UHTTR). The Pebble-in-Block fuel consists of a graphite basket and many spherical fuels. It is evident from this study that the average fuel burnup, average power density and max. fast neutron flux (E>0.18 MeV) of UHTTR can be increased through utilizing Pebble-in-Block fuel. The achievable average fuel burnup, average power density and max. fast neutron flux are 97 GWd/t, 7.2 W/cm and 6.7 x 10^{13} n/cm^2/sec, respectively. (author).

32324 (JAERI-M-90-003) **SONATINA-2H: a computer program for seismic analysis of the two-dimensional horizontal slice HTGR core.** Ikushima, Takeshi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 138p. Order Number DE90791170. Available from NTIS (US Sales Only), PC A07/MF A01.

A Computer program SONATINA-2H has been developed for predicting the behavior of a two-dimensional horizontal HTGR core under seismic excitation. SONATINA-2H is a general two-dimensional computer program capable of analyzing the horizontal slice HTGR core with the fixed side reflector blocks and its restraint structures and the core support structure. In the analytical model, each block is treated as a rigid body and represent one column of the reactor core and is connected to the core support structure by means of column springs and viscous dampers. A single dashpot model is used for the collision process between adjacent blocks. The core support structure is represented by a single block. The computer program SONATINA-2H is capable of analyzing the core behavior for an excitation input applied simultaneously in two mutually perpendicular horizontal directions. In the present report are given, the theoretical formulation of the analytical model, an user's manual to describe the input and output format and sample problems. (author).

32325 (UJV-8653-T) **HTGR reactor fuel.** Jakesova, L.; Havelka, S.; Hron, M. Ustav Jaderneho Vyzkumu CSKAE, Rez (Czechoslovakia). Jan 1989. 43p. (In Czech). Order Number DE90628207. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A critical review is given of data on the physical, chemical end other relevant properties of fuel materials and fuel elements for HTGR reactors. Available technologies for coated particles and fuel elements fabrication and appropriate quality control are described. In-core fuel behavior and spent fuel reprocessing are briefly discussed. Basic information about uranium and thorium fuel cycles is included. (author). 17 figs., 21 tabs., 87 refs.

2105 Power Reactors, Breeding

Refer also to citation(s) 32347, 32348, 32427, 32428, 32603

32326 (CONF-900418–15) **Experiments and analysis for large conventional fast reactors in ZPPR-18/19.** Brumbach, S.B.; Collins, P.J.; Carpenter, S.G.; Grasseschi, G.L. Argonne National Lab., Idaho Falls, ID (USA). [1990]. 20p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From international conference on the physics of reactors: operation, design and computation; Marseilles (France); 23-26 Apr 1990. Order Number DE90011153. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Experiments in ZPPR 18 and 19 provided physics data for large (1100 MWe) conventional LMRs. Measurements focused on the spatial distributions of fission rates and control worths. Experimental results were obtained for the fundamental to first-harmonic eigenvalue separation. In the outer core of ZPPR-18, fuel was arranged in sectors with uranium about the y axis and plutonium about the x axis. In ZPPR-19, the fuel was rearranged to give a uniform outer core distribution. Fission rate C/E values were essentially invariant with radius through the plutonium zones. The control worth C/E values were influences by their proximity to the uranium sectors. 10 refs., 5 figs., 6 tabs.

2106 Power Reactors, Auxiliary, Mobile, Package, and Transportable

Refer also to citation(s) 32357

32327 (JAERI-M-89-221) **Advanced marine reactor: Discussion of a soaking the reactor vessel in the water containment vessel upon the trial studies.** Ishizaka, Yuichi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Itoh, Yasuyoshi. Japan Atomic Energy Research Inst., Tokyo (Japan). Jan 1990. 78p. (In Japanese). Order Number DE90791119. Available from NTIS (US Sales Only), PC A05/MF A01.

A design study on the next generation advanced marine reactor MRX (Marine Reactor-x) has been developed in JAERI. The reactor is installed in the container which is filled with water. Thermal insulators are necessary for the reactor components, such as reactor vessel, pipings, etc. to reduce the heat loss and to secure the integrity of the components. A survey of the existing technology about the thermal insulating material and the entire process has been made. Design requirements of insulation are set up tentatively considering realization of In-servies Inspection and evaluating the capacity of decay heat removal in case of ship sinking. A simplified metal insulation (Millor Insulation) has been screened out and a conceptual design has been made. A study is also performed with a anti-corrosion method of the reactor vessel and the containments vessel. Outer wall of the reactor vessel to be contact with water should be protected by the arc welding of stainless steel. While coating the paint for BWR is appropriate for inner wall of the containment vessel. (author).

2107 Regulation and Licensing

Refer also to citation(s) 32365, 32376, 32378, 32419

32328 (NUREG–0750-Vol.30-Index-2) **Indexes to Nuclear Regulatory Commission issuances, July–December 1989: Volume 30, Index 2.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Freedom of Information and Publications Services. May 1990. 82p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

Digests and indexes for issuances of the Commission (CLI), the Atomic Safety and Licensing Appeal Panel (ALAB), the Atomic Safety and Licensing Board Panel (LBP), the Administrative Law Judge (ALJ), the Directors' Decisions (DD), and the Denials of Petitions for Rulemaking are presented in this document. These digests and indexes are intended to serve as a guide to the issuances.

2108 Economics

Refer also to citation(s) 32325

32329 (CCC-SR–7) **The case for coal: Evidence by the Coalfield Communities Campaign to the Hinkley Point 'C' nuclear power station inquiry.** Barrett, M. (Earth Resources Research (UK)); Jackson, T.; Berkhout, F. F.; Fothergill, S.; Witt, S.; Prior, M.; Andrews, S. Coalfields Communities Campaign, Barnsley (UK). Mar 1989. 118p. Available from The British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ. Price Pound 15.00.

Four sections, with 7 chapters present the CCC case against Hinkley Point C PWR reactor in relation to the future of the U.K. coal industry. Economics of nuclear power generation, compared to coal-fired power stations and the back end of the nuclear fuel cycle are considered. (UK).

32330 (CNIC–00129) **Analysis of economics and market for urban nuclear heating in China.** Tian Jiafu (Qinghua Univ., Beijing, BJ (China). Inst. of Nuclear Energy Technology); Xiao Hongchai; Jin Ziying. China Nuclear Information Centre, Beijing, BJ (China). Dec 1987. 13p. (In English and Chinese). (TSHUNE–0001). Order Number DE90628307. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In consideration of the heat market in northern cities, the economics of the pool-type low temperature heating reactor and the investment of urban heating system, the scale of protype reactor is chosen 200 MW, which will be able to meet the requirement of cities with more than 500 thousands population, and about 2/3 urban heat market can be met. In some areas, choosing 100 MW reactor probability is better. It is expected that the newly built apartments in North-East, North-West and North China will be about 50 million sq. meters each year and they will require some 3 GW of additional heat sources per year, and the building area incorporated into urban heating system will be 150 million sq. meters

by 1990, and 500 million sq. meters by 2000. The market demand of the nuclear heat sources will increase rapidly.

22 NUCLEAR REACTOR TECHNOLOGY

2201 Theory and Calculation

Refer also to citation(s) 32326

32331 (IKE–6-179) **Solution of the multigroup transport equations for fuel element assemblies according to the first collision procedure.** Rueckle, T. Stuttgart Univ. (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme. Jan 1990. 131p. (In German). Order Number DE90792249. Available from NTIS (US Sales Only), PC A07/MF A01.

This work presents several methods for the calculation of multidimensional, strongly heterogeneous assemblies. An approximate form of the integral neutron transport equation is used. The methods are based on variants of the first collision theory, the $J^{\pm}$-concept, the P^{k}-concept, as well as on a coupling between the both methods. They take into consideration the influence of the linear anisotropic scattering of the neutrons. This is of great interest, if strong gradients of the neutron flux appear near strong absorbing materials. The coupling of the codes, to the code system RSYST makes possible to use the calculated spectra and power distributions for different applications like burnup analysis or determination of the pin with the highest power release. For the verification of the methods, different calculations were performed and the results were compared with accurate but expensive transport methods. A good agreement with the reference calculations was reached. With the usage of a special homogenization method it is possible to obtain a good agreement between $J^{\pm}$-calculations, where only homogeneous rectangular meshes are used and coupled $J^{\pm}$- and P^{k}-calculations. By this measure it is in many case sufficient to apply the $J^{\pm}$ method with consistent partial current coupling. (orig./HP).

32332 (ORNL/FTR–3608) **[International conference on the physics of reactors]: Foreign trip report, April 20, 1990–May 6, 1990.** de Saussure, G. Oak Ridge National Lab., TN (USA). 10 May 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90011089. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler, a member of the Conference Technical Program Committee, attended the conference, PHYSOR-90, chaired a session on "Nuclear Data — Measurements and Evaluation," and gave an oral presentation (Reich-Moore and Adler-Adler Representations of the ^{235}U Cross Sections in the Resolved Resonance Region). The conference theme was the operation, design, and computation of nuclear reactors. More than 400 participants from 31 countries attended. Of particular interest to the traveler were reports on recent high-accuracy measurements of neutron cross sections of the fissile and fertile nuclei and on the validation of data and calculational methods with integral experiments.

32333 (ORNL/M–1073) **Executive summary: Reactor critical benchmark calculations for burnup credit applications.** Renier, J.P.; Parks, C. Oak Ridge National Lab., TN (USA). Apr 1990. 25p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90010315. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The requirements of ANSI/ANS 8.1 specify that calculational methods for away-from-reactor criticality safety analysis be validated against experimental measurements. Criticality safety evaluations of spent fuel storage and transportation casks have typically been benchmarked against "cold" critical experiments. This is an acceptable practice where the cask evaluation is conservatively based on fresh fuel isotopics is desired, it is necessary to benchmark computational methods against spent fuel critical configurations. This report summarizes the initial effort to benchmark selected away-from-reactor criticality analysis methods using several configurations from pressurized water reactors (PWR). Beginning-of-cycle (BOC) and end-of-cycle (EOC) reactor configurations have been analyzed. The KENO V.a module of SCALE was used to determine the effective multiplication factor (k_{eff}) while resonance self-shielding of the cross sections was performed using standard SCALE techniques. In addition, two new pre-processor codes (CONDENSE and LUMPIT) were prepared to simplify the interface between the isotopic prediction codes and the SCALE modules. Two methods were employed to predict the spent fuel isotopics: multidimensional reactor analyses (PDQ7) and point-depletion analyses using both the SAS2 sequence of SCALE and CELL2 code package. To date only the PDQ7 isotopic data have been used to analyze all the configurations. Using the SCALE 27-group cross section library, the calculated variance in K_{eff} is approximately $\pm 1.5\%$ Δk. Further refinements and additional analyses are currently in progress.

32334 **Delayed neutron data and group parameters for 43 fissioning systems.** Brady, M.C. (Oak Ridge National Lab., TN (USA)); England, T.R. *Nuclear Science and Engineering (USA)*, 103(2): 129-149 (Oct 1989).

The quality and quantity of delayed neutron precursor data have greatly improved over the past decade and a half. Supplementation of the data with model calculations and the use of models to extend the number of precursors to 271 is now practical. These data, along with other improved fission product parameters, permit direct calculations of aggregate behavior for many fissioning nuclides. The results can still be approximated using a few (usually six) temporal groups, including corresponding spectra, as in past practice for reactor physics. An extensive effort to provide a complete set of evaluated data is summarized, with an emphasis on its use to generate the temporal approximations; precursor data and group values are intended for inclusion in ENDF/B-VI.

2202 Components and Accessories

Refer also to citation(s) 32342, 32350, 32358, 32360, 32386, 32416, 32418, 32420, 32421, 32533, 32863

32335 (EPRI-NP–6629) **Guidelines for the procurement and receipt of items for nuclear power plants (NCIG-15): Final report.** Larson, J.A. (MDM Engineering Corp., San Clemente, CA (USA)); Pierson, R.K.; Houston, W.H. Electric Power Research Inst., Palo Alto, CA (USA); MDM Engineering Corp., San Clemente, CA (USA). c May 1990. 139p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This document provides guidelines for assuring the quality of procured items used in nuclear power plants by emphasizing the importance of establishing technical and quality requirements for procured items, and receiving inspection as a method of acceptance. Engineering involvement is shown to be a key element of an effective procurement program. 18 refs.

32336 (EPRI-NP–6719-M) **Proceedings: Primary water stress corrosion cracking: 1989 EPRI remedial measures workshop.** Gorman, J.A. (Dominion Engineering, Inc., McLean, VA (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Dominion Engineering, Inc., McLean, VA (USA). c Apr 1990. 18p. Sponsored by Electric Power Research Institute. (CONF-8902179–Summ.: EPRI remedial measures workshop, Clearwater Beach, FL (USA), 8-10 Feb 1989). Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A meeting on "PWSCC Remedial Measures" was organized to give those working in this area an opportunity to share their results, ideas and plans with regard to development and application of remedial measures directed against the primary water stress corrosion cracking (PWSCC) phenomenon affecting alloy 600 steam generator tubes. Topics discussed included: utility experience and strategies; nondestructive examination (NDE) methods for PWSCC; technical topics ranging from predictive methods for occurrence of PWSCC to results of corrosion tests; and services provided by vendors that can help prevent the occurrence of PWSCC or can help address problems caused by PWSCC once it occurs.

32337 (EPRI-NP–6834) **A magnetographic technique for inspection of containment welds through coatings: Final report.** Fisher, J.L. (Southwest Research Inst., San Antonio, TX (USA)); Burkhardt, G.L. Electric Power Research Inst., Palo Alto, CA (USA);

Southwest Research Inst., San Antonio, TX (USA). c May 1990. 76p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The purpose of this project was to develop an inspection technique for typical nuclear plant containment welds that could detect cracks 6 mm (0.25 inch) long or longer through paint thicknesses up to 0.38 mm (0.015 inch). A magnetographic technique was developed for this purpose. This technique incorporates a flexible magnetic medium such as magnetic recording tape which is placed into contact with the component while a magnetic field is applied. The leakage field from a flaw magnetizes the tape, and the signal from the tape can be read by scanning a magnetic tape head over the tape. In this project, both magnetic tape and a commercial product with the brand name Magnafilm were investigated for this purpose. Experimental investigations using cracks produced by a proprietary welding process showed that the magnetic tape had insufficient sensitivity; however, the Magnafilm was to have sufficient sensitivity to satisfy most of the projects goals. The Magnafilm produced permanent visual images on the Magnafilm material itself, and it could also be scanned with a tape head to produce magnetographic signals. Results were obtained from longitudinal cracks in the crown and toe of the welds in flat and 90-degree weld specimen, and from transverse cracks in the crown of the welds in the specimens. Using visual Magnafilm indications, cracks ranging in length from 5 mm (0.2 inch) to 28 mm (1.1 inches) were detectable through simulated paint thicknesses up to 0.38 mm (0.5 inch), with the exception of one 6-mm (0.25-inch) crack which was detectable through thicknesses up to 0.23 mm (0.009 inch). Based on these results, a preliminary inspection procedure for inspecting containment welds through coatings was developed. 7 refs.

32338 (NUREG/CR–5409) **Neutron exposure parameters for the metallurgical test specimens in the sixth heavy-section steel irradiation series.** Miller, L.F. (Oak Ridge National Lab., TN (USA)); Baldwin, C.A.; Stallmann, F.W.; Kam, F.B.K. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Oak Ridge National Lab., TN (USA). May 1990. 35p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. (ORNL/TM–11267). Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

The goal of the Heavy-Section Steel Irradiation (HSSI) Program Sixth Irradiation Series is to determine the effect of irradiation on the shape and shift of the crack-arrest toughness versus temperature curve. Two capsules which contained crack-arrest and Charpy V-notch test specimens have been irradiated at the Oak Ridge Research Reactor located at the Oak Ridge National Laboratory. these capsules have been disassembled, internal dosimeters have been analyzed, and exposure parameters are presented for each irradiation test specimen. This report describes the computational methodology for the least-squares presents exposure parameters at each test specimen location for the fluence rate greater than 1.0 MeV, fluence rate greater than 0.1 MeV, and displacements per atom. The specific activity of each dosimeter at the end of irradiation is listed in the Appendix. 10 refs., 8 figs., 4 tabs.

2203 Fuel Elements

Refer also to citation(s) 32198, 32325, 32779

32339 (DPST–71-317) **Effect of rib on burnout heat flux.** Hodges, M.W. Savannah River Lab., Aiken, SC (USA). 8 Apr 1971. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90011240. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Ribs contacting the surface of reactor assemblies insulate the surface and cause local reductions in coolant velocity resulting in local heat flux perturbations. These perturbations can be represented as a reduction in the burnout heat flux for surfaces contacted by a spacer rib as compared to an ideal surface, i.e., no rib present. This memorandum presents results of burnout tests with insulating ribs on aluminum surfaces and proposes a method for applying the results to reactor assemblies. 1 ref., 7 figs., 1 tab.

32340 (KFKI–1989-46/G) **Studies on vibration of fuel rods Pt. 1: Mechanical models of vibration of fuel rods in PWRs.** Lipcsei, S.; Kiss, S.; Por, G. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Sep 1989. 26p. (In Hungarian). Order Number DE90628169. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

An adequate model of dynamic behaviour of fuel rods in NPP-s was generated to estimate their eigenfrequencies. The eigenfrequencies were computed for different kind of clamps of the rods. Contrary to the usual models based on string vibration this model showed that the eigenfrequencies took place at the quadratic higher harmonics. These solutions agree with the earlier results of measurements. Changes in the eigenfrequencies of lower models were detected and interpreted by the examination of different clamping modes. (author) 6 refs.; 8 figs.

2204 Control Systems

Refer also to citation(s) 32351, 32420, 32421, 32427

32341 (EPRI-NP–6839-Vol.1) **Nuclear power applications of NASA control and diagnostics technology: Volume 1, Project results: Final report.** Touchton, R.A. (Technology Applications, Inc., Jacksonville, FL (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Technology Applications, Inc., Jacksonville, FL (USA). c May 1990. 98p. Sponsored by Electric Power Research Institute. Grant NAG10-0036. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The main objectives of Research Project RP2902-1, Nuclear Applications of NASA Control and Diagnostics Technology, were the assessment of NASA's KATE technology, development of a generic software tool suitable for use by the utility industry, and the building of a demonstration application in the power utility domain. Accordingly, the KATE technology was studied, evaluated and the essential features selected for reimplementation in a generic, user-friendly tool called "ProSys." ProSys represents a growing interest in the use of computer systems to represent structural and functional information of complex physical systems and to deduce the causes for their undesired behavior. Recent attempts have concentrated on representing such knowledge and drawing inferences using a generic, model-based approach. The Reactor Coolant Pump Seal System, including a few alarms, was selected and modeled as a demonstration application. Prioritization of alarms was performed using functional relationships specified by the user as part of the model. Following this, an experiment was conducted on the modeling and diagnosis of flow systems using more heuristic techniques. In general, it was proven that given enough information about the physical system in the form of a complete model, a generic system can monitor and troubleshoot the physical system. The main advantage of such a generic system is that it is very easy to maintain and extend, because any change in the design of the physical system need only be reflected in the model. The development methodology and tasks also contributed significantly to the understanding of strengths and weaknesses of the KATE technology and gave direction towards addressing the weakness. 16 figs., 5 tabs.

32342 (EPRI-NP–6839-Vol.2) **Nuclear power applications of NASA control and diagnostics technology: Volume 2, Technical report: Final report.** Touchton, R.A. (Technology Applications, Inc., Jacksonville, FL (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Technology Applications, Inc., Jacksonville, FL (USA). c May 1990. 80p. Sponsored by Electric Power Research Institute. Grant NAG10-0036. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The main objective of Research Project RP2902-1, Nuclear Applications of NASA Control and Diagnostics Technology, were the assessment of NASA's KATE technology, development of a generic software tool suitable for use by the utility industry, and the building of a demonstration application in the power utility domain. Accordingly, the KATE technology was studied, evaluated and the essential features selected for reimplementation in a generic, user-friendly tool called "ProSys." ProSys represents a growing interest in the use of computer systems to represent the causes for their undesired behavior. Recent attempts have concentrated on representing such knowledge and drawing inferences using a generic, model-based approach. Thus ProSys is a model-based diagnostic

program that runs on a microcomputer. It is built on basic principles of troubleshooting, such as cause and effect, and not on experiential heuristics. Models built using ProSys store a knowledge of the structure and function of the system that is being diagnosed. ProSys uses this knowledge to draw inferences about the current state of the system. ProSys is also knowledgeable about the command inputs (operator actions) to the system and the effect that these have on the sensors. Thus, ProSys expects certain values from the sensors and when those are different, it works backwards to hypothesize the failure of system components. This document, Volume 2, provides a technical discussion of the system. 17 figs.

32343 (EPRI-NP–6839-Vol.3) **Nuclear power applications of NASA control and diagnostics technology: Volume 3, Users manual: Final report.** Touchton, R.A. Electric Power Research Inst., Palo Alto, CA (USA); Technology Applications, Inc., Jacksonville, FL (USA). c May 1990. 72p. Sponsored by Electric Power Research Institute. Grant NAG10-0036. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The purpose of this volume is to provide user instructions for ProSys, a modeling and diagnostic tool, which was developed under contract RP2902-1, Nuclear Power Applications of NASA Control and Diagnostics Technology. Two companion documents have been published: Volume 1–Project Results and Volume 2–Technical Report. General project results are presented in Volume 1 and detailed (computer sciences) aspects of the entire effort are presented in Volume 2.

32344 (JAERI-M–89-223) **HTTR plant dynamic simulation using a hybrid computer.** Shimazaki, Junya (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Suzuki, Katsuo; Nabeshima, Kunihiko; Watanabe, Koichi; Shinohara, Yoshikuni; Nakagawa, Shigeaki. Japan Atomic Energy Research Inst., Tokyo (Japan). Jan 1990. 59p. (In Japanese). Order Number DE90791130. Available from NTIS (US Sales Only), PC A04/MF A01.

A plant dynamic simulation of High-Temperature Engineering Test Reactor has been made using a new-type hybrid computer. This report describes a dynamic simulation model of HTTR, a hybrid simulation method for SIMSTAR and some results obtained from dynamics analysis of HTTR simulation. It concludes that the hybrid plant simulation is useful for on-line simulation on account of its capability of computation at high speed, compared with that of all digital computer simulation. With sufficient accuracy, 40 times faster computation than real time was reached only by changing an analog time scale for HTTR simulation. (author).

2205 Environmental Aspects

Refer also to citation(s) 32417, 32426

32345 (EGG-M–89276) **Fission product release as a function of chemistry and fuel morphology.** Hobbins, R.R.; Osetek, D.J.; Petti, D.A.; Hagman, D.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 11p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. (CONF-890546–9: ICHMT international seminar on fission product transport processes in reactor accidents, Dubrovnik (Yugoslavia), 22-26 May 1989). Order Number DE90010945. Available from NTIS, PC A03/MF A01; OSTI; INIS.

Analysis of the consequences of severe reactor accidents requires knowledge of the location and chemical form of fission products throughout the accident sequence. Two factors that strongly influence the location and chemical form of fission products are the chemistry within the core and the morphology of the fuel or fuel-bearing debris. This paper reviews the current understanding of the these factors garnered from integral and separate effect experiments and the TMI-2 accident, and provides perspective on the significance of contributing phenomena for the analysis of severe accidents, particularly during the in-vessel phase. Information has been obtained recently on phenomena affecting the release of fission products from fuel and the reactor vessel during the in-vessel melt progression phase of a severe accident. The influence of a number of these phenomena will be reviewed, including fuel chemistry, H_2/H_2O ratio, fuel liquefaction, molten pools, and debris beds. 13 refs., 1 fig., 1 tab.

32346 (EGG-M–90151) **Highlights of the OECD [Organization for Economic Cooperation and Development] LOFT [Loss-of-Fluid Test] LP-FP-2 experiment including hydrogen generation, fission product chemistry, and transient fission product release fractions.** Carboneau, M.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 24p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-9005179–1: Loss of Fluid Test final meeting (achievements of the OECD LOFT Project), Madrid (Spain), 8-11 May 1990). Order Number DE90010916. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The purpose of this paper is to present the primary highlights of the OECD LOFT Experiment LP-FP-2. These highlights include the chemistry of the released fission products, the transient fission product release fractions, and the total amount and distribution of hydrogen generated during the experiment. As determined from the upper plenum coupon data, it is concluded that CsI was not present in significant concentrations during the experiment. Instead, AgI and CsOH appear to have been the primary fission product species for I and Cs. Based on the blowdown suppression tank (BST) data and the on-line gamma spectrometer data, the transient releases of volatile fission products ranged from 2% to 5% of the initial center fuel module (CFM) inventory. However, the major release of volatile fission products occurred during reflood and amounted to an additional release of 9% to 14%. The primary reason for the small transient release fractions was the initially large grain structure of the fuel ($\sim$14 μm) and the smaller than expected peak transient fuel temperatures (2300 K to 2700 K). The amount of hydrogen gas measured in the BST was 205 $\pm$ 11 g, and the amount estimated in noncondensable bubbles in the primary coolant system (PCS) was 819 $\pm$ 364 g. Thus, the total amount of hydrogen released during LP-FP-2 was 1024 $\pm$ 364 g. This quantity of hydrogen is equivalent to an oxidation of 58% of the initial zircaloy mass. Since most of the hydrogen generated during the transient should have been transported to the BST, it appears that the large amount of hydrogen observed in the PCS was generated after the PCS was isolated; that is, following reflood. 4 refs., 15 figs., 3 tabs.

32347 (EGG-NPD–8836) **Reference site selection report for the advanced liquid metal reactor at the Idaho National Engineering Laboratory.** Sivill, R.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). Mar 1990. 69p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90010936. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

This Reference Site Selection Report was prepared by EG&G, Idaho Inc., for General Electric (GE) to provide information for use by the Department of Energy (DOE) in selecting a Safety Test Site for an Advanced Liquid Metal Reactor. Similar Evaluation studies are planned to be conducted at other potential DOE sites. The Power Reactor Innovative Small Module (PRISM) Concept was developed for ALMR by GE. A ALMR Safety Test is planned to be performed on a DOE site to demonstrate features and meet Nuclear Regulatory Commission Requirements. This study considered possible locations at the Idaho National Engineering Laboratory that met the ALMR Prototype Site Selection Methodology and Criteria. Four sites were identified, after further evaluation one site was eliminated. Each of the remaining three sites satisfied the criteria and was graded. The results were relatively close. Thus concluding that the Idaho National Engineering Laboratory is a suitable location for an Advanced Liquid Metal Reactor Safety Test. 23 refs., 13 figs., 9 tabs.

32348 (EGG-NPD–8837) **Advanced Liquid Metal Reactor site selection criteria report.** Sivill, R.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). Jan 1990. 12p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90010937. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

General Electric (GE) initiated and developed the concept of the Power Reactor Innovative Small Module (PRSIM) liquid metal cooled reactor in the 1980s. The intent was to develop a low cost,

demonstrably safe, reliable, electrical power generator. Some preliminary site assessments were performed in 1986 and 1987 for the prototype test, primarily looking at the economics of using existing facilities at various potential sites for performance of the safety tests on one reactor module. In 1989, the New Programs Department of EG&G Idaho was asked to develop the methodology and criteria for a more rigorous site selection process, expanding the scope of interest from the original economics for a one reactor module safety test to also include National Environmental Policy Act (NEPA) considerations, NRC siting regulations, ALMR design requirements, and the addition of a steam generator module and turbine-generator for the power producing phase. The methodology and criteria were to be developed for use at any potential DOE site. EG&G Idaho was also requested to perform a pilot study at the Idaho National Engineering Laboratory (INEL) using the newly developed methodology and criteria. This study was for instructional purposes only; DOE will make the final determination on site selection.

32349 (GAO/RCED–89-119) **Nuclear regulation: NRC's decommissioning procedures and criteria need to be strengthened.** General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div. Aug 1989. 51p. Available from US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877 (USA).

Today, 112 nuclear power plants, 22 facilities that support these plants, 54 reactors used in research, and approximately 23,000 organizations hold licenses from either the Nuclear Regulator Commission or various states to use radioactive material; other facilities are operated by various government agencies. Eventually most of these facilities will be decommissioned, which involves removing the radioactive material and terminating the license. NRC needs to ensure that licensees appropriately decontaminate their facilities because, under current regulations, NRC cannot specifically require additional cleanup once it terminates a license. This paper presents a GAO report on NRC's decommissioning procedures. In two of eight cases GAO reviewed, NRC fully or partially released sites for unrestricted use where radioactive contamination was higher than its guidelines allowed; in the other cases, NRC's information was inadequate or incomplete. Further, NRC lacks information on the types and amounts of radioactive waste buried on-site. At five sites reviewed by GAO, groundwater has been found to be contaminated by radioactive waste.

2206 Research, Test, and Experimental Reactors

Refer also to citation(s) 32323, 32344, 32376, 32546, 32703, 32851, 32863, 33221

32350 (EGG-M–89074) **Replacement of core components in the Advanced Test Reactor.** Durney, J.L. (EG and G Idaho, Inc., Idaho Falls, ID (USA)); Croucher, D.W. EG and G Idaho, Inc., Idaho Falls, ID (USA); International Atomic Energy Agency, Vienna (Austria). [1989]. 11p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (IAEA-SM–310/21;CONF-891027–8: International symposium on research reactor safety, operations and modifications, Chalk River (Canada), 23-27 Oct 1989). Order Number DE90010942. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The core internals of the Advanced Test Reactor are subjected to very high neutron fluences resulting in significant aging. The most irradiated components have been replaced on several occasions as a result of the neutron damage. The surveillance program to monitor the aging developed the needed criteria to establish replacement schedules and maximize the use of the reactor. Methods to complete the replacements with minimum radiation exposures to workers have been developed using the experience gained from each replacement. The original design of the reactor core and associated components allows replacements to be completed without special equipment. The plant has operated for about 20 years and will continue operation for perhaps another 20 years. Aging evaluations are in program to address additional replacements that may be needed during this extended time period. 3 figs.

32351 (EGG-M–89075) **Replacement of the Advanced Test Reactor control room.** Durney, J.L. (EG and G Idaho, Inc., Idaho Falls, ID (USA)); Klingler, W.B. EG and G Idaho, Inc., Idaho Falls, ID (USA); International Atomic Energy Agency, Vienna (Austria). [1989]. 8p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (IAEA-SM–310/18P;CONF-891027–7: International symposium on research reactor safety, operations and modifications, Chalk River (Canada), 23-27 Oct 1989). Order Number DE90010943. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The control room for the Advanced Test Reactor has been replaced to provide modern equipment utilizing current standards and meeting the current human factors requirements. The control room was designed in the early 1960 era and had not been significantly upgraded since the initial installation. The replacement did not change any of the safety circuits or equipment but did result in replacement of some of the recorders that display information from the safety systems. The replacement was completed in concert with the replacement of the control room simulator which provided important feedback on the design. The design successfully incorporates computer-based systems into the display of the plant variables. This improved design provides the operator with more information in a more usable form than was provided by the original design. The replacement was successfully completed within the scheduled time thereby minimizing the down time for the reactor. 1 fig., 1 tab.

32352 (JAERI-M–90-008) **Evaluation of reactivity coefficients for High Temperature Engineering Test Reactor (HTTR).** Yamashita, Kiyonobu (Japan Atomic Energy Research Inst., Oarai, Ibaraki (Japan). Oarai Research Establishment); Shindo, Ryuichi; Murata, Isao; Nakagawa, Shigeaki; Nakata, Tetsuo; Tokuhara, Kazumi. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 53p. (In Japanese). Order Number DE90791148. Available from NTIS (US Sales Only), PC A04/MF A01.

This report presents the evaluation methods and evaluated results of doppler-, moderator temperature- and power coefficients for High Temperature Engineering Test Reactor (HTTR). From this study, it was made clear that the HTTR possesses inherent power-suppressing feed back characteristic due to the negative power coefficient though the moderator temperature coefficient is slightly positive due to the accumulated isotopes ^{135}Xe and ^{239}Pu. (author).

32353 (KFKI–1989-42/I) **Monte Carlo modelling for neutron guide losses.** Cser, L.; Rosta, L.; Toeroek, Gy. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Sep 1989. 14p. Order Number DE90628209. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In modern research reactors, neutron guides are commonly used for beam conducting. The neutron guide is a well polished or equivalently smooth glass tube covered inside by sputtered or evaporated film of natural Ni or ^{58}Ni isotope where the neutrons are totally reflected. A Monte Carlo calculation was carried out to establish the real efficiency and the spectral as well as spatial distribution of the neutron beam at the end of a glass mirror guide. The losses caused by mechanical inaccuracy and mirror quality were considered and the effects due to the geometrical arrangement were analyzed. (author) 2 refs.; 2 figs.

32354 (KURRI-TR–321) **Summary reports of activities under visiting research program in Research Reactor Institute, Kyoto University, 1988.** Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. Jul 1989. 62p. (In Japanese). Order Number DE90791245. Available from NTIS (US Sales Only), PC A04/MF A01.

The Technical Report of Research Reactor Institute, Kyoto University, is published on occasion summarizing in the form of prompt report the results of the functional test on various experimental facilities, the test results of the articles made for trial, the circumstance of radiation control and waste treatment, the data required for research and experiment such as the reports of study meetings, the remarkable results obtained amid research, new method, the discussion on other papers and reports and others. In this report, 40 summaries of the Visiting Research Projects utilizing the KUR and 13 summaries of those utilizing the KUCA in 1988,

and 2 unreported summaries before 1988 are collected. In each summary, the number of adoption, title, the names of reporters and the gist of report are given. (K.I.).

32355 (UJV–8308-F,R) **Determination of neutron flux densities in WWR-S reactor core.** Tomasek, F. Ustav Jaderneho Vyzkumu CSKAE, Rez (Czechoslovakia). Apr 1989. 58p. (In Czech). Order Number DE90625093. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The method is described of determining neutron flux densities and neutron fluences using activation detectors. The basic definitions and relations for determining reaction rates, fluence and neutron flux as well as the characteristics of some reactions and of sitable activation detectors are reported. The flux densities were determined of thermal and fast neutrons and of gamma quanta in the WWR-S reactor core. The data measured in the period 1984-1987 are tabulated. Cross sections for the individual reactions were determined from spectra measurements processed using program SAND-II and cross section library ENDF-B IV. Neutron flux densities were also measured for the WWR-S reactor vertical channels. (E.J.). 10 figs., 8 tabs., 111 refs.

2207 Plutonium and Isotope Production Reactors

Refer also to citation(s) 32232, 32339, 32359

2209 Reactor Safety

Refer also to citation(s) 32255, 32259, 32319, 32345, 32346, 32462, 32551, 32552, 33046

32356 (CONF-9006173–1) **A probabilistic approach to the evaluation of the PTS [pressurized thermal shock] issue.** Cheverton, R.D.; Selby, D.L. Oak Ridge National Lab., TN (USA). [1990]. 29p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. From US-USSR exchange meeting on reactor safety; Moscow (USSR); 25-29 Jun 1990. Order Number DE90010717. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The pressurized-thermal-shock (PTS) issue is concerned with the possibility of failure of pressurized-water-reactor (PWR) pressure vessels under a very specific set of conditions. These conditions include: (1) the occurrence of reactor transients that subject the vessel to severe thermal shock as well as the normal pressure loading, (2) the existence of sharp, crack-like defects (flaws) at the inner surface of the vessel wall, and (3) high enough fast neutron fluence and concentrations of copper and nickel in the vessel wall to result in a extensive radiation-included reduction in the fracture toughness of the vessel material. Under these conditions, the mechanism for vessel failure involves propagation of the flaws through the vessel wall, in which case adequate containment of coolant for the core might not be possible. The portion of the vessel of concern is the so-called beltline region because, it is directly opposite the core (high influence rate), it is adjacent to the coolant downcomer (potential for thermal shock), and coolant leakage in this area would tend to uncover the core. This document discusses the behavior of flaws in reactor pressure vessels under pressure and thermal-shock loading conditions.

32357 (DOE/OR/00033–T38) **Review of overall safety manual for space nuclear systems: An evaluation of a nuclear safety analysis methodology for plutonium-fueled space nuclear systems.** Coleman, J. (Sigma Associates (USA)); Inhaber, H. Oak Ridge Associated Universities, Inc., TN (USA). Feb 1984. 78p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC05-76OR00033. Order Number DE90010925. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

As part of its duties in connection with space missions involving nuclear power sources, the Office of Nuclear Safety (ONS) of the Office of Assistant Secretary for Environmental Protection, Safety, and Emergency Preparedness has been assigned the task of reviewing the Overall Safety Manual (OSM). The OSM, dated July 1981 and in four volumes, was prepared by NUS Corporation, Rockville, Maryland, for the US Department of Energy. As noted in the work statement, the task was to review the OSM in a broad way without concentrating on the details. Consistent with the work statement, reviewing the risk models was emphasized. Our effort included an evaluation of the overall risk analysis methodology presented in the manual and the technical rationale supporting the methodology. In addition, other aspects of the OSM were evaluated such as its usability, data base, and so on. The review of these other aspects was required in order to provide a comprehensive picture of the value of the document.

32358 (EGG-M–89106) **Ranking significant phenomena in physical systems.** Dimenna, R.A.; Larson, T.K. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 11p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-891103–71: Winter meeting of the American Nuclear Society, San Francisco, CA (USA), 26-30 Nov 1989). Order Number DE90010983. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The analysis of any physical system requires a thorough understanding of the principal phenomena affecting the behavior of that system. In a complex application such as a nuclear reactor, identifying the principal phenomena in an accident transient can be a formidable task. This paper describes the use of the analytical hierarchy process to assimilate engineering judgements that relate and rank the thermal-hydraulic phenomena affecting the response of a nuclear reactor. The analytical hierarchy process is described to acquaint the reader with the methodology. The importance criterion against which phenomena are selected, measured, and ranked is discussed and defined for the example application described here. The purpose of the analysis, in this case to determine the applicability of a computer code to represent the system phenomena, is defined. The hierarchy used to structure the pairwise decisions is developed in terms of both the importance criterion and the goal of assessing computer code applicability. The methodology is applied to a loss-of-feedwater transient in a nuclear reactor as an example. The analysis shows the application of engineering judgement based on experimental and calculational experience to rank both the system components and the local phenomena within those components relative to each other on a pairwise basis. The same engineering experience is used to assess the validity of the final results. The application of the overall ranking to a code applicability and uncertainty assessment is then discussed. 4 refs., 7 figs., 5 tabs.

32359 (EGG-M–89113) **Development of a PIRT (phenomena identification and ranking table) for a postulated double-ended guillotine break in a production reactor.** Hanson, R.G. (EG and G Idaho, Inc., Idaho Falls, ID (USA)); Wilson, G.E.; Ortiz, M.G.; Griggs, D.P. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 14p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-891103–72: Winter meeting of the American Nuclear Society, San Francisco, CA (USA), 26-30 Nov 1989). Order Number DE90010952. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The US Nuclear Regulatory Commission has developed a generic methodology to quantify the uncertainty in best estimate computer codes used to license commercial light water reactors. This same methodology is equally applicable to other reactor designs with regards to providing a technical basis which supports the establishment and demonstration of compliance with safe operating margins. One of the cornerstones of the method is the identification and ranking of phenomena that are important to the postulated scenario. This paper references descriptions of the total methodology, describes the first three steps (i.e, through the identification and ranking of phenomena), and summarizes the results of the application of the methodology to a double-ended guillotine break loss of coolant accident in a production reactor. 6 refs., 8 figs., 5 tabs.

32360 (EGG-M–89114) **CSAU (code scaling, applicability and uncertainty), a tool to prioritize advanced reactor research.** Wilson, G.E. (EG and G Idaho, Inc., Idaho Falls, ID (USA)); Boyack, B.E. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 9p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. (CONF-891103–70: Winter meeting of the American Nuclear Society, San Francisco, CA (USA), 26-30 Nov 1989). Order Number DE90010903. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Best Estimate computer codes have been accepted by the US Nuclear Regulatory Commission as an optional tool for performing safety analysis related to the licensing and regulation of current nuclear reactors producing commercial electrical power, providing their uncertainty is quantified. In support of this policy change, the NRC and its contractors and consultants have developed and demonstrated an uncertainty quantification methodology called CSAU. At the process level, the method is generic to any application which relies on best estimate computer code simulations to determine safe operating margins. The primary use of the CSAU methodology is to quantify safety margins for existing designs; however, the methodology can also serve an equally important role in advanced reactor research for plants not yet built. Applied early, during the period when alternate designs are being evaluated, the methodology can identify the relative importance of the sources of uncertainty in the knowledge of each plant behavior and, thereby, help prioritize the research needed to bring the new designs to fruition. This paper describes the CSAU methodology, at the generic process level, and provides the general principles whereby it may be applied to evaluations of advanced reactor designs. 9 refs., 1 fig., 1 tab.

32361 (EGG-M–89219) **A model for a recovery of a badly degraded core.** Sharon, A. (Fauske and Associates, Inc., Burr Ridge, IL (USA)); Henry, R.E. Wu, Chun-Der; Hammersley, R.J. EG and G Idaho, Inc., Idaho Falls, ID (USA); Fauske and Associates, Inc., Burr Ridge, IL (USA). [1989]. 40p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-891103–73: Winter meeting of the American Nuclear Society, San Francisco, CA (USA), 26-30 Nov 1989). Order Number DE90010932. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A model for a recovery of a badly degraded core is presented for application to severe accident analysis of advanced light water reactors. The purpose of the model is to asses the potential amount and rate of in-vessel hydrogen generation and aid in the evaluation of accident management strategies. A review of the available data from the TMI-2 accident on primary system and core behavior during a core uncovery, after portions of the core have reached melting temperatures, is conducted for pertinent application to the model. Consistency between the model predictions and data is demonstrated. The effect of new model on a recovery sequence in a typical pressurized water reactor is also presented. 15 refs., 15 figs., 1 tab.

32362 (EGG-M–89329) **Living PRAs [probabilistic risk analysis] made easier with IRRAS [Integrated Reliability and Risk Analysis System].** Russell, K.D. (EG and G Idaho, Inc., Idaho Falls, ID (USA)); Sattison, M.B.; Rasmuson, D.M. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 33p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. (CONF-890855–60: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989). Order Number DE90010938. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Integrated Reliability and Risk Analysis System (IRRAS) is an integrated PRA software tool that gives the user the ability to create and analyze fault trees and accident sequences using an IBM-compatible microcomputer. This program provides functions that range from graphical fault tree and event tree construction to cut set generation and quantification. IRRAS contains all the capabilities and functions required to create, modify, reduce, and analyze event tree and fault tree models used in the analysis of complex systems and processes. IRRAS uses advanced graphic and analytical techniques to achieve the greatest possible realization of the potential of the microcomputer. When the needs of the user exceed this potential, IRRAS can call upon the power of the mainframe computer. The role of the Idaho National Engineering Laboratory if the IRRAS program is that of software developer and interface to the user community. Version 1.0 of the IRRAS program was released in February 1987 to prove the concept of performing this kind of analysis on microcomputers. This version contained many of the basic features needed for fault tree analysis and was received very well by the PRA community. Since the release of Version 1.0, many user comments and enhancements have been incorporated into the program providing a much more powerful and user-friendly system. This version is designated "IRRAS 2.0". Version 3.0 will contain all of the features required for efficient event tree and fault tree construction and analysis. 5 refs., 26 figs.

32363 (EGG-M–89393) **The RELAP5/MOD3 computer code.** Weaver, W.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 16p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-8909248–2: 6. international RETRAN meeting, Arlington, VA (USA), 18-20 Sep 1989). Order Number DE90010947. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

RELAP5/MOD3 is a pressurized water reactor (PWR) system analysis code being developed jointly by the U.S. Nuclear Regulatory Commission (USNRC) and a consortium consisting of several of the countries and domestic organizations that are members of the International Code Assessment and Applications Program (ICAP). The mission of the RELAP5/MOD3 code development program is to develop a code version suitable for the analysis of all transients and postulated accidents in PWR systems including both large and small break loss of coolant accidents (LOCA's) as well as the full range of operational transients. Although the emphasis of the RELAP5/MOD3 development is on large break LOCA, improvements to existing code models, based on the results of assessments against small break LOCA and operational transient test data, are also being made. This paper discusses the new code models as well as improvements to existing models. 13 refs., 6 figs., 1 tab.

32364 (EGG-M–89412) **Mechanical damage experience in major light water reactor systems.** Ware, A.G. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 8p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. (CONF-900617–12: Pressure vessels and piping conference: be in tune for the 90's, Nashville, TN (USA), 17-21 Jun 1990). Order Number DE90010922. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper describes the nuclear power industry's experience with mechanical (as opposed to thermal or electrochemical) damage in the major systems of light water reactor (LWR) plants. Almost all of the occurrences of damage were caused by mechanical vibration. The sources of vibration include flow-induced vibration, water-hammer events, and pump and valve vibration. However, the damage has sometimes been initiated or aggravated by other sources, such as stress corrosion cracking, loss of preload, or corrosion-fatigue. Mechanical vibration can also cause metal loss in the walls of thin tubes when they impact with their supports. Some of the components that have experienced mechanical damage are reactor coolant pump shafts, PWR and BWR reactor vessel internals, PWR instrument tubes, thermal sleeves in piping, and steam generator tubes. Various mitigation methods can be implemented to reduce or eliminate these problems. 18 refs., 5 figs., 1 tab.

32365 (GAO/RCED–89-95) **Nuclear regulation: NRC's restart actions appear reasonable-but criteria needed.** General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div. Jun 1989. 17p. Available from US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877 (USA).

As of November 1988, seven nuclear plants were shut down to correct safety and/or management problems. However, the Nuclear Regulatory Commission does not have criteria that specify the actions that must be taken before a plant can restart operations. In November 1988, NRC's Executive Director for Operations issued staff guidelines, but the guidelines do not go far enough. The guidelines do not discuss public participation, independent review, or utility actions prior to restarting a plant. This paper presents some recommendations made in a GAO report. Among these recommendations are the following: NRC needs to establish criteria to ensure that a consistent process is used to assess the readiness of any plant that has been shut down for management and/or safety problems. The criteria should describe both NRC and utility actions that must be taken before allowing a plant to restart operations. The criteria should be flexible enough to allow NRC to add

requirements on a plant-by-plant basis giving consideration to overall design, personnel, and management.

32366 (IKE–4-132) **Modelling of the steam-water-countercurrent flow in the rewetting and flooding phase after loss-of-coolant accidents in pressurized water reactors.** Curca-Tivig, F. Stuttgart Univ. (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme. Jan 1990. 267p. (In German). Order Number DE90792247. Available from NTIS (US Sales Only), PC A12/MF A01.

A new interphase momentum exchange model has been developed to simulate the Refill- Reflood Phase after LOCAs. Special phenomena of steam/water- countercurrent flow - like limitation or onset of downward-watee penetration - have been modelled and integrated into a flooding model. The interphase momentum exchange model interconnected with the flooding model has been implemented into the advanced system code RELAP5/MOD1. The new version of this code can now be utilized to predict the hot leg emergency-core-cooling (ECC) injection for German PWRs. The interfacial momentum transfer model developed includes the interphase frictional drag, the force due to virtual mass and the momenta due to interphase mass transfer. The modelling of the interfacial shear or drag accounts for the effects of phase and velocity profiles. The flooding model predicts countercurrent-flow limitation, onset of water penetration and partial delivery. The flooding correlation specifies the maximum down flow liquid velocity in case of countercurrent flow through flow restrictions for a given vapor velocity. (orig./HP).

32367 (INIS-XN–231) **General report of the Insurance Study Committee.** International Union of Producers and Distributors of Electrical Energy (UNIPEDE), Paris (France). 1988. 15p. (CONF-8805371–: Sorrento Congress of the Insurance Study Committee, Sorrento (Italy), 30 May - 3 jun 1988). Order Number DE90628322. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This general report gives the main objectives which the Insurance Study Committee intends to follow, an overview of the work undertaken from 1985-1988 and some points that the Committee considers its duty to underline, propose or recommend in the field of risk management. It concludes with the report of the Group of Experts on Third Party Liability and Nuclear Insurance, set up in 1986 to study and prepare the position to be taken by UNIPEDE on nuclear third party liability matters at the Group of Governmental Experts on Nuclear Third Party Liability and at the IAEA Standing Committee on Civil Liability for Nuclear Damage.

32368 (INIS-XN–232) **Risks and nuclear insurance.** Debaets, M. (Societes Reunies d'Energie du Bassin de l'Escaut (Belgium)); Springett, G.D.; Luotonen, K.; Virole, J. International Union of Producers and Distributors of Electrical Energy (UNIPEDE), Paris (France). 1988. 45p. (CONF-8805371–: Sorrento Congress of the Insurance Study Committee, Sorrento (Italy), 30 May - 3 jun 1988). Order Number DE90628323. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

When analysing the nuclear insurance market, three elements must be taken into account: the nuclear operator's liability is regulated by national laws and/or international Conventions, such operators pay large premiums to insure their nuclear installations against property damage and finally, the nuclear insurance market is made up of pools and is mainly a monopoly. This report describes the different types of insurance coverage, the system governing nuclear third party liability under the Paris Convention and the Brussels Supplementary Convention and several national laws in that field. The last part of the report deals with liability and insurance aspects of international transport of nuclear materials.

32369 (JAERI-M–89-213) **Sensitivity analyses on reflooding effect on the TMI-2 accident by the SCDAP code.** Hidaka, Akihide (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Sugimoto, Jun; Soda, Kunihisa; Matsumoto, Eiichi. Japan Atomic Energy Research Inst., Tokyo (Japan). Dec 1989. 93p. (In Japanese). Order Number DE90791106. Available from NTIS (US Sales Only), PC A05/MF A01.

Sensitivity analyses were performed in order to investigate the effect of reflooding on the hydrogen generation and temperature rise of the fuel cladding due to Zr-water reaction. The sensitivity analyses were conducted for the TMI-2 accident assuming that the reflooding was initiated by an operator action between 100 and 174 minutes after the accident initiation. The following conclusions were obtained from the present sensitivity analyses. (1) There is a possibility of temperature rise of cladding in the upper part of the core during the reflooding as was observed in the CORA-12 experiment at KfK, in the case when the reflooding was assumed to be initiated in the TMI-2 accident by an operator action during 100≈174 minutes after the accident initiation. (2) Reflooding of degraded core could result in hydrogen generation and temperature rise of the upper fuel cladding in the case that the core condition before reflooding was under steam starvation, temperature of the remaining unoxidized Zr was at about 1500 K and the reflooding was slow. (3) For accident management of severe accident, the relationship between hydrogen generation, initiation timing and rate of reflooding should be taken into account. (J.P.N.).

32370 (JAERI-M–89-220) **Data report for ROSA-IV LSTF 5% cold leg break LOCA experiment Run SB-CL-08.** Kukita, Yutaka (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Hirata, Kazuo; Koizumi, Yasuo. Japan Atomic Energy Research Inst., Tokyo (Japan). Jan 1990. 139p. Order Number DE90791144. Available from NTIS (US Sales Only), PC A07/MF A01.

Experimental data for the 5% cold leg break test, Run SB-CL-08, conducted at the ROSA-IV Large Scale Test Facility (LSTF) on July 10, 1986, are presented. This test was part of a test series which addressed the steam generator (SG) liquid holdup effects on the core liquid level depression associated with loop seal clearing during a cold leg small-break loss-of-coolant accident (SBLOCA) in a pressurized water reactor (PWR). The test assumed total failure of both high pressure injection (HPI) and auxiliary feedwater systems. Core uncovering occurred twice in the test. The first level drop which occurred during loop seal clearing was enhanced by the asymmetry of liquid holdup between the SG upflow and downflow sides. The core was uncovered temporarily, nearly to the core bottom, but was recovered as soon as loop seals were cleared. The second core uncovering occurred due to vessel coolant inventory boil-off and was terminated by an automatic actuation of accumulators. (author) 8 tabs. 94 figs. 10 refs.

32371 (JAERI-M–89-224) **Determination of the long-lived nuclides in biological shielding concrete, ion exchange resin and fuel storage pool water of JPDR.** Takeishi, Hideyo (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Suzuki, Toshio; Iso, Shuichi; Kohno, Nobuaki; Hoshino, Akira; Yonezawa, Chushiro; Hatakeyama, Mutuo; Komori, Takuji. Japan Atomic Energy Research Inst., Tokyo (Japan). Jan 1990. 54p. (In Japanese). Order Number DE90791131. Available from NTIS (US Sales Only), PC A04/MF A01.

In relation to the planning and implementation of the decommissioning programs of nuclear facilities, field work programs and treatment/disposal programs of the radioactive wastes for the establishment of the reactor decommissioning technology, it is essentially important to obtain the basic data for estimating the radionuclide inventory of nuclear facilities. For the estimation of radionuclide inventory, it is necessary to determine especially the long-lived nuclides, such as ^{14}C, ^{3}H, ^{60}Co, ^{134}Cs, ^{137}Cs, ^{152}Eu, ^{154}Eu and ^{239}Pu, among the radionuclides generated in the reactor material during reactor operation. Among these nuclides, γ-ray emitting nuclides can be measured by the nondestructive analyses, and on the other hand, α- and β-ray emitting ones are necessary to be measured by the destructive analyses including individually chemical separation. At the Decommissioning Waste Managing Division, Department of JPDR, the destructive analyses for γ-ray emitting nuclides have been carried out for the samples taken out from the reactor materials of JPDR, but the analyses for α- and β-ray emitting nuclides have not been done because the methods for these nuclides had not yet been developed. Since the measurements of these α- and β-ray emitting nuclides are indispensable for the comprehensive estimation of radionuclide inventory, the analytical methods for these nuclides were developed at the Analytical Chemistry Laboratory, Department of Chemistry, and the

methods were applied to the analysis of the real amount of the long-lived nuclides in the biological shielding concrete, the ion exchange resin for the purification of the cooling water, and the pool water for the storage of nuclear fuel. The procedures and the results are described in the report. (author).

32372 (JAERI-M–89-225) **Data report for ROSA-IV LSTF 5% hot leg break experiment Run SB-HL-01.** Kukita, Yutaka (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Murakami, Hiroyori; Koizumi, Yasuo. Japan Atomic Energy Research Inst., Tokyo (Japan). Jan 1990. 125p. Order Number DE90791132. Available from NTIS (US Sales Only), PC A06/MF A01.

Experimental data for the 5% hot leg break test, Run SB-HL-01, conducted at the ROSA-IV Large Scale Test Facility (LSTF) on July 30, 1986, are presented. This test was part of a test series which studied the break location effects on small-break loss-of-coolant accident (SBLOCA) transients, and assumed total failure of both high pressure injection (HPI) and auxiliary feedwater (AFW) systems. The test results were characterized by asymmetric loop responses, flashing in the cold legs as well as upper downcomer, and condensation depressurization in the cold legs following injection of emergency core coolant (ECC) from accumulators. (author).

32373 (JAERI-M–89-227) **Evaluation report on CCTF Core-II reflood test C2-AA2 (Run 58): investigation of downcomer injection effects.** Okubo, Tsutomu (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Iguchi, Tadashi; Sugimoto, Jun; Akimoto, Hajime; Murao, Yoshio. Japan Atomic Energy Research Inst., Tokyo (Japan). Jan 1990. 105p. Order Number DE90791138. Available from NTIS (US Sales Only), PC A06/MF A01.

This report is an evaluation report of the CCTF Core-II test C2-AA2 (Run 58). In this test the ECC water was injected into the downcomer as well as into the intact cold legs in order to investigate characteristics of thermo-hydrodynamic behavior in a downcomer injection test. For this purpose, the test conditions were determined to be the same as those for the base case test (Test C2-4 (Run 62)) except for the ECC water injection locations. The ECC water injection location in the base case test was only the cold leg. Comparing the data of the present test with those of the base case test, the following results are obtained. (1) The present test experienced a significant periodic oscillation. (2) Thermal equilibrium by mixing of ECC water and steam flowing in the intact loops was not established at the downcomer in the present test, and hence, downcomer fluid temperature was observed to be subcooled and lower than in the base case test. (3) Fluid temperature at the core inlet was higher than in the base case test. Quenching of heater rods were slightly later than in the base case test. (4) Although thermo-hydrodynamic behavior through the system was oscillatory in the present test, average values of the oscillatory data were nearly identical to those of the base case test except for the differences mentioned in items (2) and (3) above. This suggests, for analysis or prediction of core cooling for the downcomer injection case, it would be possible to use the same models, methods or computer codes as used for the cold leg injection case with adding a modification on predicting the fluid temperature at the core inlet. (J.P.N.).

32374 (KFK–4694) **Florestan-Material Test.** Wiehr, K. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Reaktorbauelemente; Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Nukleare Sicherheit. Mar 1990. 49p. (In German). Order Number DE90792468. Available from NTIS (US Sales Only), PC A03/MF A01.

This report describes an experiment, which had the aim, to deform Zircaloy-claddings in a triangular bundle array with a pitch over diameter ratio of 1.2 as large as possible by ballooning under internal overpressure. The FLORESTAN-Material Test, which has to be regarded as a proper material test, was performed under test conditions not typical of a reactor. The bundle consisted of 61 fuel rod simulators with Zircaloy claddings. At a nearly constant cladding temperature of 800deg C the claddings were pressurized with Helium-gas of 8.4 MPa. The atmosphere was stagnant steam of 0.4 MPa. The plastic deformation of the claddings developed under isothermal and nearly adiabatic conditions. A very low decay heat simulation, not typical of reactor accident conditions, was chosen to cover heat losses caused by natural convection of the steam and heat losses of the test section. The assessment of the coolant channel blockage was concentrated on the clads of the 37 inner rod positions. The time of deformation from pressurization to burst was less than one minute. The plastic deformation of the claddings showed a pronounced coplanarity of the locations of the maximum ballooning at the axial midplane of the bundle. This resulted also in deformations of the bundle housing, i.e., the housing attained a convex shape. The claddings of the rods partially were wrinkled into one another. The result of the experiment were large circumferential strains a burst up to 91% and a resulting theoretical coolant channel blockage for the inner 37 claddings of 100% over an axial length of 7 cm. (orig.).

32375 (KFKI–1989-44/G) **3.5% cold leg break test without hydroaccumulator application: Computerized measurement analysis.** Szabados, L.; Ezsoel, Gy.; Perneczky, L. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Sep 1989. 100p. (In Hungarian). Order Number DE90628165. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

Cold leg break simulation tests were performed in the PMK-NHV test facility for the research of LOCA processes. The results of experiments with high-pressure emergency cooling system but without the use of hydroaccumulators (SITs) in operation modelling a 3.5% cold leg break are presented. The measurement data were processed by computer calculations using the RELAP4/mod6 code. These tests were the extensions of the 7.4% cold leg break simulations reported earlier. (R.P.) 8 refs.; 51 figs.; 2 tabs.

32376 (NUREG–1390) **Safety Evaluation Report related to the renewal of the operating license for the TRIGA training and research reactor at the University of Arizona (Docket No. 50-113).** Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation. May 1990. 72p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A04/MF A01 - GPO; OSTI; INIS.

This Safety Evaluation Report for the application filed by the University of Arizona for the renewal of Operating License R-52 to continue operating its research reactor at an increased operating power level has been prepared by the Office of Nuclear Reactor Regulation of the US Nuclear Regulatory Commission. The facility is located on the University of Arizona campus in Tucson, Arizona. The staff concludes that the reactor can continue to be operated by the University of Arizona without endangering the health and safety of the public. 20 refs., 8 figs., 5 tabs.

32377 (NUREG/CP–0095, pp. 11-26) **Containment long-term operational integrity–a 1988 status report.** Sammataro, R.F. (General Dynamics Corporation, Groton, CT (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

Design and in-service codes and standards provide a comprehensive set of requirements for containment design, construction, inspection, testing and repair. Metal and concrete containments must be designed, fabricated, constructed, inspected, tested and maintained to quality standards commensurate with the importance of the safety function to be performed. Periodic integrated leak rate tests are required to assure that containments continue to meet allowable leakage limits. Although overall performance has been quite good to date, several major containment aging and degradation mechanisms have been identified. Two pilot plant life extension studies, one for a boiling water reactor and one for a pressurized water reactor, serve as models for extending the operational integrity of present containments in the United States. Research and testing programs for determining the ultimate pressure capacity and failure mechanisms for containments under severe loading conditions and studied for extending the life of current plants beyond the present 40 year licensed lifetime are underway. This paper presents an overview of containment designs in the USA

and a discussion of the regulatory and ASME Code requirements for the design, construction, in-service inspection, testing and repair for containments. Findings for containments from the pilot plant life extension studies and the ongoing containment research and testing programs are also discussed. The regulatory and ASME Code requirements for design, construction, in-service inspection and periodic integrated leakage testing together with recommendations from the plant life extension studies and containment integrity research and testing provide a basis for continued containment long-term operational integrity.

32378 (NUREG/CP–0095, pp. 27-36) **Containment integrity beyond the design basis: A UK regulatory view.** Todd, I.W. (HM Nuclear Installations Inspectorate, Merseyside (England)). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

The regulation of nuclear installations in the United Kingdom is carried out by means of a licensing system which is administered on behalf of the Health and Safety Executive by HM Nuclear Installations Inspectorate. A major part of the licensing process lies in the assessment of the licensee's pre-construction safety report, which must be submitted to the Inspectorate before a nuclear site license may be granted. This paper describes the assessment of the containment for the UK's first PWR, Sizewell B. In particular, it addresses the margins existing in its structural design, which provide reserves of strength to withstand events beyond the design basis. This work has been guided by the Inspectorate's published Safety Assessment Principles and by international PWR experience. The UK's experience in the design, construction and operation of prestressed concrete pressure vessels is also of some relevance. The contributions from each, in areas such as design validation by model testing and quality assurance arrangements are described. The paper concludes that this work should demonstrate the acceptability of the Sizewell B containment design, both within and beyond the design basis. Construction is programmed to commence in July 1988.

32379 (NUREG/CP–0095, pp. 37-46) **Design considerations for severe accident containment performance.** Davis, G.A. (Combustion Engineering, Inc., Windsor, CT (USA)); Matzie, R.A.; Green, M.D.; Brewer, H.D.; Fox, W.A. III. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

Containment designs for current light water reactors are based on conservative design bases which have resulted in structures that are very rugged with substantial margins to failure. For future advanced light water reactors (ALWRs), severe accident concerns must be considered in addition to the traditional design bases when designing containment structures. Although new, prescriptive regulations for severe accident design bases are not necessary (and could be counterproductive), acceptance criteria for resolution of severe accident concerns must be established in a timely manner to support the development these ALWRs. This paper suggests an approach to developing such acceptance criteria and identifies the major severe accident technical issues which need to be resolved for future containment designs.

32380 (NUREG/CP–0095, pp. 77-92) **Proposed acceptance criteria for severe accident evaluations of steel containment vessels.** Edwards, N.W. (NWE Services, Inc., Morgan Hill, CA (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

It would be useful for the industry to at least adopt a load resistance acceptance criteria so that current designs, or possible design modifications, could be evaluated on a consistent basis, given a set of postulated loadings. Currently, it can be observed that the individual analysts are left on their own to pick both analysis methods and acceptance criteria. This paper proposed that existing, time tested criteria are already available to serve as the common denominator for determining whether or not a given steel containment vessel has design features adequate to withstand the effects of a given severe accident loading scenario. It presents results of an effort where state-of-the-art, non-linear analysis techniques were applied, and computed vessel responses were reviewed in light of basic material failure criteria versus ASME Section III, Class MC, Service Level C and Service Level D acceptance criteria. The comparisons are encouraging enough to suggest that if steel containment vessels are eventually required to be the subject of industry wide, consistent severe accident loading response evaluations, the off-normal service level limits currently defined in Subsection NE of Section III of the ASME Boiler and Pressure Vessel Code can be utilized to form the basis of an industry wide, consistent design acceptance criteria.

32381 (NUREG/CP–0095, pp. 95-110) **Containment loading by deliberate ignition of flammable gas mixtures.** Carcassi, M. (Universita degli Studi di Pisa (Italy)); Carnasciali, F.; Fineschi, F. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

As a result of a severe accident, there may be a flammable hydrogen-air-steam mixture inside the containment of a nuclear plant. Hydrogen control systems are provided to prevent deflagrations which would be dangerous for the containment integrity. Among these, deliberate ignition should make the hydrogen burn as soon as the mixture becomes flammable, so that, after the deflagration, the pressure is as low as possible. Realistic flammability limits and deflagration efficiencies have been estimated from 848 experimental tests to assess whether temperature and concentrations of a hydrogen-air-steam mixture permit a safe, effective deliberate ignition. A graphic method is proposed to identify the steam-saturated hydrogen-air mixtures whose deflagrations can cause containment failure.

32382 (NUREG/CP–0095, pp. 127-146) **Parametric CONTAIN calculations of the containment response of the Grand Gulf plant due to reactor pressure vessel failure at high pressure.** Murata, K.K.; Louie, D.L.Y. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

A parametric study of the containment response of the Grand Gulf plant, a Mark III BWR, has been conducted using the CONTAIN code. The response to extensive debris dispersal following reactor pressure vessel failure at high pressure is examined for a short period after vessel failure, for plant conditions corresponding to a short-term station blackout scenario with water on the floor of the drywell. The discussion of results from this study focuses on the peak drywell-wetwell pressure difference, the peak pedestal pressure, and the potential for drywell flooding after debris dispersal.

32383 (NUREG/CP–0095, pp. 147-160) **Ice melting progress in a nonuniformly loaded ice condenser facility.** Tuomisto, H. (Imatran Voima Oy, Helsinki (Finland)); Hongisto, O. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17

Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

In large ice condensers the sublimation processes are inevitable in the long term. The sublimation processes create maldistribution of initially uniformly loaded ice beds. Difficult and laborious ice replacement has to be carried out to meet the Technical Specifications, which typically allow only a 10% variation in the single ice basket loadings. This limit is dictated by the fear of hot steam discharged during loss-of-coolant accidents or steam line breaks penetrating the ice bed. This channeling effect might then result in excessive containment pressures. methods taking nonuniformities into account in calculating containment response to loss-of-coolant and steam line break accidents are not available. That is why Imatran Voima Oy decided to build an experimental facility of its own to model the Loviisa ice condenser and to study the phenomena mentioned above. This paper describes the experimental program including a series of blowdown experiments and a series of combined blowdown and longer-term experiments simulating large loss-of-coolant accident sequences.

32384 (NUREG/CP–0095, pp. 195-210) **Maintaining leak tightness capability of Caorso BWR containment.** Barsanti, P. (ENEA - DISP, Rome (Italy)); Di Palo, L.; Grimaldi, G. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

In 1987 the local leak rate test (LLRT) results of the primary containment were revised, with the following main goals: to highlight recurring problems, leading to lack of leak tightness of the primary containment; to individuate the pertinent degradation mechanisms; to assess the corrective actions already implemented and to plan further improvements, if necessary; and to optimize the preventive maintenance program on the containment, particularly the inspection frequency. All LLRTs in the past operating period, both before (as found) and after (as left) maintenance were analyzed, in terms of leakage rate and equivalent area of leak, for each penetration. Corrective actions already implemented included replacement of some valves with better quality type one, passivation of the carbon steel pipes and improvement of the pertinent surveillance procedures. Long term corrective actions, now under consideration, will include the following: more extensive passivation of pipes, carrying humid air, so that oxidation could be drastically reduced; better chemistry control in fluid systems; extensive replacement of the butterfly valves presently used; implementation of the LLRT practice, such to quantitatively measure the leakage rate, also in presence of large leak; and reduction of the time interval between periodical tests, on the basis of the results of the previous ones. Following these guidelines, future overall leakage tests would be performed in as found condition, aimed to verify the effectiveness of the entire maintenance and testing program of the primary containment and of its capability to maintain leak tightness during the time between two subsequent tests.

32385 (NUREG/CP–0095, pp. 111-126) **Development of a hydrogen mitigation strategy for degraded core accidents in a BWR/6 - Mark III power plant.** Centanaro, C. (Ansaldo S.P.A., Genova (Italy)). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

Since the Three Mile Island accident, when the concern about the combustion of large quantities of hydrogen arose, the hydrogen mitigation problem has been analyzed in Ansaldo S.P.A. Technical Development Research Programs. Besides, after the 10.CFR 50.44 rule on degraded core accidents (Jan. 25,'85) fixed at 75% the extent of hydrogen production from Metal Water Reaction in the active core cladding to be disposed, the selection of a suitable mitigation strategy became a major issue for a two-units 218/624 BWR/6 - Mark III Italian plant now at about 80% of construction stage. After a comparison among several mitigation strategies, the deliberate ignition with thermal ignitors was selected and the analysis of containment response to hydrogen burning became a major issue. As the latest results from experimental tests have outlined that even in severe hydrogen release accident only a slight impact on containment pressurization is anticipated but relevant thermal loads could be imposed on EFS Systems components nearby the combustion area, a new program has started to evaluate the survivability of equipment essential for containment safety.

32386 (NUREG/CP–0095, pp. 179-192) **Seismic uplift of nuclear containments.** Stevenson, J.D. (Stevenson & Associates, Cleveland, OH (USA)); Huckelbridge, A.; Mital, S. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

Historically lateral inertia acceleration using modal analysis, response spectrum procedures has played a major role in the seismic-resistant design process for nuclear containments. Significant computational complications arise, however, when such procedures are applied to problems involving seismic uplift or overturning which now involves nonlinear response. Any realistic assessment of actual uplift response should include consideration simultaneously of both force and displacement response parameters (or the corresponding energy parameter resulting from their product) as has been discussed in several past studies. This paper has included the size effect in evaluating the response of structures which considers the potential for uplift. While non-linear effects due to lift off are generally of little consequence to containment design parameters, the nonlinear effects associated with the tip displacement for small structures are significantly greater than for larger structures with the same seismic excitation. The paper concludes that for building and containment design, nonlinear response need not be considered explicitly for seismic inertia acceleration levels at least twice that required to initiate uplift.

32387 (NUREG/CP–0095, pp. 211-230) **The influence of data collection rate, containment size and data smoothing on containment Integrated Leak Rate Tests.** Wagner, W.T. (Sentry Equipment Corp., Oconomowoc, WI (USA)); Langan, J.P.; Norris, W.E.; Lurie, D. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

Phase I of a U.S. Nuclear Regulatory Commission contract investigated nuclear power plant Integrated Leak Rate Tests (ILRTs) using data gathered at many domestic and foreign ILRTs. The study evaluated ILRTs with the ANS criteria (in ANSI/ANS-56.8-1987) and the proposed extended ANS criteria (in draft Regulatory Guide, Task MS 021-5, October 1986). The study considered (1) the effects of data collection rates on ILRT conclusions, (2) a possible relationship between containment size, data collection rate and ILRT duration, (3) the impact of the proposed extended ANS methodology on ILRTs, and (4) the influence of data smoothing on ILRT data. The study was performed using 20 sets of Type A and 17 sets of verification data.

32388 (NUREG/CP–0095, pp. 231-242) **Proving Test on the Reliability for Reactor Containment Vessel.** Takumi, K. (Nuclear Power Engineering Test Center, Tokyo (Japan)); Nonaka, A. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA

(USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

NUPEC (Nuclear Power Engineering Test Center) has started an eight-year project of Proving Test on the Reliability for Reactor Containment Vessel since June 1987. The objective of this project is to confirm the integrity of containment vessels under severe accident conditions. This paper shows the outline of this project. The test items are (1) Hydrogen mixing and distribution test, (2) Hydrogen burning test, (3) Iodine trapping characteristics test, and (4) Structural behavior test. Based on the test results, computer codes are verified and as the results of analysis and evaluation by the computer codes, containment integrity is to be confirmed.

32389 (NUREG/CP–0095, pp. 243-258) **Comparison between calculated and measured eigenfrequencies for spherical steel containment shells.** Eberle, F. (Kernforschungszentrum Karlsruhe GmbH (West Germany)); Goeller, B.; Krieg, R. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

Some eigenmodes and several hundreds of eigenfrequencies were measured for a very accurate spherical steel containment model. Even the influence of the surrounding air could be observed. Comparison with computational results shows that todays' structural dynamics models seem to be able to predict the dynamic shell response very well, provided the spatial resolution is sufficient. Based on these results the influence of shell imperfections which are typical for real containments will be investigated in the next step. Using the law of similarity all the results can easily be transferred from the model to the full scale containment.

32390 (NUREG/CP–0095, pp. 259-274) **Experimental study for structural behavior of reinforced concrete containment vessel beyond design pressure.** Saito, H. (Tokyo Electric Power Co., Inc. (Japan)); Oyamada, O.; Muramatsu, Y.; Hasegawa, T.; Tanaka, N. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

The first Advanced Boiling Water Reactor (ABWR) including a reinforced concrete containment vessel (RCCV) is scheduled to be constructed in 1990's, in Japan. As RCCV itself has not been experienced in Japan, the authors performed trial design, several series of fundamental experiments and partial/total model experiments. This paper shows a summary of TOP SLAB EXPERIMENT carried out as one of partial model experiments, in which structural behavior of the RCCV under internal pressure was examined.

32391 (NUREG/CP–0095, pp. 291-306) **Proposals for a one tenth scale model test of the Sizewell B containment.** Lomas, C. (Central Electricity Generating Board, Gloucester (England)). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

The CEGB is to carry out a pressure test on a one tenth scale prestressed concrete model of the Sizewell B containment building in order to validate the computer codes used in the design and analysis of the full scale structure. This test will fulfill a commitment given to H.M. Nuclear Installations Inspectorate. This paper outlines the principal reasons lying behind the decision to carry out the test and lists the overall objectives. The test proposals are discussed in detail along with the program for the work.

32392 (NUREG/CP–0095, pp. 307-324) **The design of a 1/10th scale model of the Sizewell B Primary Containment.** Smith, J.C.W. (Nuclear Design Associates, Cheshire (England)). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

The paper describes the design of a 1/10th scale model of the Sizewell B Primary Containment which is being constructed and pressure tested by the CEGB to provide a validation of the design methods used for the full-size structure and justifications given for items which differ significantly from the full-size. Results of analyses of the model to ultimate failure conditions are described which detail the expected failure mode and the pressures associated with design limit states. Details are also given of the tests to be carried out on the materials used in the construction of the model.

32393 (NUREG/CP–0095, pp. 377-394) **Progress in post-test analyses of a 1:6 scale lined and reinforced concrete containment model.** Bachmann, P. (Gesellschaft fuer Reaktorsicherheit (GRS) mbH, Koeln (West Germany)); Gruner, P.; Eisert, P.; Kuntze, W.; Eibl, J.; Schlueter, F.H. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

The status of sill continuing post-test analyses was presented. Considerable improvements of the calculated global behavior of the 1:6 scale reinforced concrete containment model were achieved. Causes of discrepancies in the predicted deformations of the basemat as compared with test results could be traced. A significant improvement of the performance of the basemat was obtained by incorporating the interaction between fill slab and basemat into the global model. In particular, deviations of dome apex displacements from experiment could almost completely be removed. Various other effects such as variations in soil stiffness, friction between basemat and mudmat, etc., though suited to reduce the discrepancies even further, do not have the same potential as the fill slab does. As it is believed that the main cause for the originally too large deviations of analysis results from test results has been found, further investigations concerning the global behavior are presently not pursued. Further efforts are directed towards the analysis of liner failure as it happened in the test at some 145 psi, both analytically and experimentally.

32394 (NUREG/CP–0095, pp. 395-408) **NFAP calculation of pressure response of 1/6th scale model containment structure.** Costantino, C.J. (Brookhaven National Laboratory, Upton, NY (USA)); Pepper, S.; Reich, M. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

The details associated with the NFAP calculation of the pressure response of the 1/6th scale model containment structure are discussed in this paper. Comparisons are presented of some of the primary items of interest with those determined from the experiment. It was found from this comparison that the hoop response of the containment wall was adequately predicted by the NFAP finite element calculation, including the response in the high pressure, high strain range at which cracking of the concrete and yielding of the hoop reinforcement occurred. In the vertical or meridional direction, it was found that the model was significantly softer than predicted by the finite element calculation; that is, the vertical strains in the test were three to four times larger than computed in the NFAP calculation. These differences were noted even at low strain levels at which the concrete would not be expected to be

cracked under tensile loadings. Simplified calculations for the containment indicate that the vertical stiffness of the wall is similar to that which would be determined by assuming the concrete fully cracked. Thus, the experiment indicates an anomalous behavior in the vertical direction.

32395 (NUREG/CP–0095, pp. 325-340) **Synopsis of the results of a test of a reinforced concrete containment.** Horschel, D.S. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

Sandia National Laboratories completed the testing of a 1:6-scale containment building for a Light Water Reactor in July 1987. The containment building was made of reinforced concrete and had many of the features found in full-size containments. The test program consisted of a structural integrity test, an integrated leak rate test, and concluded with an overpressurization test of the structure. The subject paper emphasizes the overpressurization test of the containment model.

32396 (NUREG/CP–0095, pp. 343-356) **Some post-test analyses of the 1/6th Sandia containment.** Bleackley, M.H. (SRD, UKAEA, Warrington (England)). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

A post-test study on the major liner tear and the measured basemat uplift of the 1/6th scale Sandia reinforced concrete containment has been conducted. A 45 degree section of the containment wall in the region of the observed 22 liner tear has been analyzed. The basemat uplift has been investigated by primarily modifying the uniaxial material properties of the concrete.

32397 (NUREG/CP–0095, pp. 357-376) **Comparison between theoretical and experimental results of the 1/6 scale concrete model under internal pressure.** Riviere, J. (CEA/IPSN, Fontenay aux Roses (France)); Barbe, B.; Millard, A.; Koundy, V. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

The prevision of the behavior of the 1/6 scale concrete model under internal pressure was realized by means of two computations, the first one with an infinite soil rigidity, the second one with a soil rigidity equal to 61.26 MPa/m. These two computations, that assumed a perfectly axisymetric structure gave theoretical and experimental results in good agreement, except the raft of which the theoretical uplift was three times higher than the experimental one. The main conclusions of this study are as follow: the soil stiffness has no influence on the ultimate behavior of the model, the dead concrete rigidity decreases the raft uplift in an important way, the model is destroyed because the hoop stress reaches the ultimate strength.

32398 (NUREG/CP–0095, pp. 425-440) **Analysis predictions vs. test results of the 1:6-scale reinforced concrete containment tested at Sandia National Laboratories.** Orsini, G. (ENEA-DISP, Rome (Italy)); Pino, G. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

Pre-test analysis results obtained at ENEA-DISP are compared with test measures, looking mainly at the critical sections where global structural failure could initiate if the liner had not leaked. In addition, major disagreements among analytical and test results are presented, and finally, results of post-test analyses for examining the liner tearing and parameters influencing basemat deformation are discussed.

32399 (NUREG/CP–0095, pp. 441-458) **Analytical correlation and post-test analysis of the Sandia 1:6 scale reinforced concrete containment test.** Dameron, R.A. (ANATECH Research Corp., San Diego, CA (USA)); Dunham, R.S.; Rashid, Y.R.; Tang, H.T. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

The EPRI-sponsored methodology for the ultimate load analysis of concrete containment structures has been utilized for conducting extensive pre-test predictions and subsequent post-test analysis and correlation of the Sandia 1:6 scale model test. The methods consist of ABAQUS-EPGEN, a general purpose nonlinear finite element code, combined with recently developed reinforced concrete modeling capabilities. Pre-test analyses using these methods predicted leakage failure and the correct leakage pressure that occurred in the model test. Two-dimensional pre-test analyses were performed to establish global results, and three-dimensional pre-test local analyses were used to model local regions near penetrations. These regions are usually more heavily reinforced and have thickened liners. They behave as stiff inclusions in a heavily cracked surrounding wall, thus resulting in high liner strains along the edge of the thickened liner. This tearing mechanism predicted by analysis was borne out in the test by a large tear next to a rectangular multiple penetration insert and many small tears next to hatches and other penetrations. The paper describes comparisons of the test with pre-test analysis and results of 2D and 3D post-test studies. Post-test axisymmetric analyses were used to investigate basemat uplift behavior and the effect of changing concrete tensile strength. A 3D local analysis was used to study the behavior at the largest liner tear that occurred. Conclusions of the paper assess the analytical methodology in light of the test results.

32400 (NUREG/CP–0095, pp. 409-424) **Post-test analysis of a piping penetration in a 1:6-scale model of a reinforced concrete containment building.** Weatherby, J.R. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988. (SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

An overpressurization experiment was conducted on a scale-model of a reinforced concrete containment building. The test was terminated at an internal pressure of 145 psig due to excessive leakage through tears that developed in the steel liner. Virtually all leakage occurred through a 22-inch tear that propagated along the edge of a thickened insert plate that surrounded a piping penetration. This paper describes the results of a post-test finite element analysis of this region. Results of the analysis, visual observations, and thickness measurements all indicate that the 22-inch tear initiated due to high strains near a stud anchor. The results of the analysis also suggest that a relatively simple analytical technique can be used to estimate the pressure at which tears will initiate near penetrations in lined containment structures made of reinforced concrete.

32401 (NUREG/CP–0095, pp. 459-474) **3-D FEM analysis of 1:6 scale reinforced concrete containment under static overpressurization and local analysis of liner plant tearing.** Baw, J.I. (Taiwan Power Company, Taipei (Taiwan)); Cheng, W.H.; Hsiau, H.N.; Cheng, S.C.; Hwang, I.T.; Ting, K. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering Standards; Sandia National Labs., Albuquerque, NM (USA). Nov 1988.

(SAND–88-1836;CONF-880616–: 4. workshop on integrity of containments for nuclear power plants, Arlington, VA (USA), 14-17 Jun 1988). In *Fourth workshop on containment integrity. Proceedings.* Order Number DE89004641. Available from NTIS, PC A99/MF A01 - I.

From the Quick Look Report for the model overpressurization-to-failure test sponsored by USNRC and conducted by Sandia Laboratories, the notion that concrete containment will leak before catastrophic burst under excess pressure was well proven. Instead of defining the ultimate pressure of gross failure, the more realistic characterization of containment failure may be in defining the leakage rate which leads to a limit peak pressure and rapid depressurization. The tearing of the liner plate has been proven to be one of the major causes of leakage. The objective of this study is an attempt to develop a methodology to simulate the local behavior of liner plate around the penetration area by using three dimensional analysis. A 3-D model was generated covering a quarter of the concrete containment to investigate the global behavior of the model and to provide boundary conditions for the local model analysis. The equipment hatch and personnel airlock were included in the analysis model. Computer code ANSYS version 4.3 3-D reinforced concrete solid element (ELEMENT 65) was used to model the concrete and rebars; plastic triangular shell element (ELEMENT 48) was used to model the liner plate; and the concrete soil interaction was considered to allow basemat liftoff. An analysis by taking an unit strip of the containment was also performed to compare the result sensitivity, analysis time and cost evaluation. The local model analysis included a fine mesh representation of the penetration area around z=13'-0, 0=45°. Special attention was placed on the discussion of liner plate behavior in the intersection of different plate thicknesses.

32402 (NUREG/CP–0104, pp. 1.15-1.16) **Reactivity accidents: A reassessment of the design-basis events.** Diamond, D.J. (Brookhaven National Lab., Upton, NY (USA)); Hsu, C.J.; Fitzpatrick, R. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

The required safety analysis for light water reactors includes various reactivity events which must be shown to result in acceptable consequences in order for plants to be licensed. Although it is possible to hypothesize reactivity events that might lead to unacceptable consequences, in the past such unanalyzed events were either precluded by specific design features or required combinations of causative events which were judged too improbable to be of concern. The objective of this study was to develop as complete a list as possible of hypothetical reactivity events and then to screen these events in light of current knowledge to determine if any might require detailed analysis. The goal of the study was to either reconfirm or bring into question previous judgments on the adequacy of the reactivity events required for analysis. The screening was done by performing probabilistic and/or deterministic calculations and, where available using the research of others. The focus of the study was influenced by the accident at Chernobyl. That event provided the incentive for this study to concentrate on accidents with relatively large reactivity insertions that could cause rapid fuel damage. In order to focus the study even more, the pressurized water reactor (PWR) analysis concentrated on a Westinghouse plant of four-loop design and the boiling water reactor (BWR) analysis on a BWR/4 design. However, reference is made to other designs throughout the report as the goal was to reach general conclusions that would be applicable to all PWRs or BWRs.

32403 (NUREG/CP–0104, pp. 1.3-1.4) **Responding to emergencies: How organization and management make a difference.** Metlay, D.S. (Brookhaven National Lab., Upton, NY (USA)); Haber, S.B.; Luckas, W.J. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

There is an observable and definable process that occurs during the course of responding to an abnormal event at a nuclear power plant (NPP). Each of the elements that comprise that process involves collective action and, consequently, is influenced by the character and effectiveness of organizational and managerial arrangements. Factors which affect each element include overt ones like the allocation of authority and responsibility and the skill of the personnel, as well as covert factors like the methods used to resolve uncertainty. The purpose of this research project is to examine the process of response that occurs to an abnormal event at a NPP and where possible, to identify the organizational and managerial factors that influence that process. The first task in this project involved the review and analysis of an extensive volume of documentation, primarily Nuclear Regulatory Commission (NRC) documents. Based on the documentation reviewed during the first task of this project, it is possible to specify an observable and definable process for response to accident and emergency situations in a NPP. The process can be described by eight major elements; the initiating transient, information about plant behavior, diagnosing the problem, availability of emergency procedures, adequacy of emergency procedures, implementing emergency procedures, developing an ad hoc response evaluating an ad hoc response and implementing an ad hoc response. Importantly, the process to be described is an iterative one. Procedures and improvised responses are executed sequentially and the results of action are assessed and additional steps are taken if necessary.

32404 (NUREG/CP–0104, pp. 1.9-1.10) **Recriticality in a boiling water reactor following a core damage accident.** Tokarz, R. (Pacific Northwest Lab., Richland, WA (USA)); Libby, R. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. DOE Contract AC06-76RL01830. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

This paper will address the potential for a recriticality following core damage after a hypothetical loss-of-coolant accident in a boiling water reactor (BWR). The domain of conditions under which a recriticality is possible, as well as the consequences of a recriticality accident, will be discussed. The core damage accident scenario is assumed to consist of the following events: (1) loss of coolant, (2) dry-out of core, (3) heat-up of fuel and control blade material, (4) melting and removal from core region of control blade material, and (5) eventual reflood of the core with water. The reflood could occur either before or after significant damage to the fuel occurs. It is possible for a BWR to experience a recriticality following such a core damage accident. In the dry state, the core cannot be made critical, since criticality for dry uranium systems is possible only with fuel enrichments greater than 5 wt% ^{235}U. When the core is reflooded, however, criticality is possible. In the event that only unborated water is accessible (or is the first available water supply), it is important that reactor operators know the conditions under which recriticality is possible and the consequences of such a recriticality. The paper will provide estimates of the energy release and peak power resulting from analysis of the bounding case. The power levels obtained will be compared to full power reactor operation. Potential accident management strategies such as lower coolant addition rates and alternate means for boration of emergency water will be discussed. Comments will also be made on future work relating to recriticality and the resulting energy releases from specific accident sequences.

32405 (NUREG/CP–0104, pp. 2.1-2.2) **Heavy-section steel technology program - Fracture issues.** Pennell, W.E. (Oak Ridge National Lab., TN (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. DOE Contract AC05-84OR21400. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

Experience with the operation of commercial nuclear power plants, including data from reactor vessel surveillance programs, has identified areas in which the fracture prevention technology embodied in the present generation of national consensus Codes and standards requires extension and/or refinement. Surveillance program data indicate that the Charpy upper-shelf fracture energy for a number of operating reactor vessels with high-copper welds will fall below the 50 ft lb. lower bound acceptance limit set by Appendix G to 10 CFR 50 before the plants reach the end of their current licensing period. This development generates a need for an extension of existing fracture prevention criteria, and the supporting fracture mechanics technology, to determine if, and under what circumstances, these plants could be permitted to operate beyond the currently defined licensing limits. Surveillance and research reactor data from the High-Flux isotope Reactor (HFIR) at ORNL have indicated accelerated irradiation embrittlement under conditions which raise concerns relative to the long term structural integrity of some reactor vessel supports. Upcoming plant life-extension actions further emphasize the need to upgrade fracture prevention technology and the associated regulatory Codes and Standards to fully reflect current understanding of the long term effects of irradiation embrittlement. Understanding of the full range of fracture issues and limitations associated with potential pressurized-thermal-shock (PTS) events continues to evolve with respect to fracture modes, models, and data-range requirements. Development and validation of the fracture prevention technology advances required to meet these needs is the major thrust of the ongoing HSST program at ORNL.

32406 (NUREG/CP–0104, pp. 6.3-6.4) **Aging risk assessment methodology: Demonstration study on a PWR auxiliary feedwater system.** Wolford, A.J. (Idaho National Engineering Lab., Idaho Falls (USA)); Atwood, C.L.; Roesener, W.S. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

The problem of analyzing age-dependent plant risk necessitates rethinking a basic principle of PRA; the assumption that all equipment failure probabilities are constant. This paper presents a methodology to detect and quantify increasing failure rates. The methodology is applied to a 16 year old PWR auxiliary feedwater system. Based on plant-specific maintenance data and the accompanying PRA, this study concludes that statistically significant age-dependent trends exist and that the implied core damage frequency is increasing, and identifies which equipment items are the major age-dependent contributors to core damage frequency. A useful product of the work is the development of a step-by-step procedure for aging risk assessment. 1 fig., 2 tabs.

32407 (NUREG/CP–0104, pp. 6.7-6.8) **Life assessment procedures for major LWR components.** Shah, V.N. (Idaho National Engineering Lab., Idaho Falls (USA)); MacDonald, P.E.; Turner, A.P.L.; Jaske, C.E.; Weidenhamer, G.H. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. DOE Contract AC07-76ID01570. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

The Aging Assessment and Mitigation Project is a part of the USNRC Nuclear Plant Aging Research Program. The main objective of the project is to develop an understanding of the aging degradation of the major light water reactor (LWR) structures and components and to develop procedures for predicting the useful life of these components so that the impact of aging on the safe operation of nuclear power plants can be evaluated and addressed. This paper describes the current status of the project and presents life assessment procedures for pressurized water reactor (PWR) steam generator tubes and LWR cast stainless steel components.

32408 (NUREG/CP–0104, pp. 7.15-7.16) **Preliminary observations of upcoming Phase II gate valve flow interruption tests.** Steele, R. (Idaho National Engineering Lab., Idaho Falls (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

A current research program sponsored by the US Nuclear Regulatory Commission (NRC) and conducted by researchers from the Idaho National Engineering Laboratory (INEL) is testing the ability of full-scale flexible wedge gate valves to close under design basis flow and pressure loadings. The purpose of this program is to provide technical information for the USNRC effort regarding Generic Issue 87, Failure Of The HPCI Steamline Without Isolation. Phase I testing was completed in June 1988, and results are being analyzed. The objective of Phase II of the program is to expand the technical data base in determining whether isolation valves in high energy BWR piping systems will close against high flows in the event of a pipe break outside containment. Generic Issue 87 includes those BWR process lines that communicate with the primary system, pass through containment, and contain normally open isolation valves. Three process lines fall under this description: (1) the high pressure coolant injection (HPCI) steam supply line, (2) the reactor core isolation cooling (RCIC) steam supply line, and (3) the reactor water cleanup (RWCU) supply line. Of the three, an unisolated break in the RWCU supply line was determined to have the greatest safety impact and was the subject of the Phase I test program. The Phase II test program will be configured to answer questions raised by results of the Phase I testing on the RWCU valves and will include steam flow interruption testing representative of the HPCI system.

32409 (NUREG/CP–0104, pp. 8.5-8.6) **Human factors survey of advanced instrumentation and controls.** Carter, R.J. (Oak Ridge National Lab., TN (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

The nuclear power industry has used analog instrumentation and controls (I and C) in their control rooms and technical support centers since the first nuclear power plant went on-line in the late 1950's. Even today the industry, as a whole, has been slow to implement advanced/digital I and C. The utilization of digital I and C appears, however, to be the wave of the future because most of the analog components and systems are becoming obsolete and no longer available. These advanced systems will also probably be utilized in the life extension of nuclear plants. It has been demonstrated in other industries that digital I and C provides almost error-free performance that is three-to-four orders of magnitude better than analog components performing the same function. With the increase in sophistication in the operation of modern nuclear power plants that is needed to handle the multiple (and sometimes conflicting) goals of efficiency, reliability, economic operation, and safety, the nuclear industry will be driven to the use of advanced I and C. Oak Ridge National Laboratory (ORNL) is currently performing a research project for the Nuclear Regulatory Commission's (NRC) Office of Nuclear Regulatory Research. The purpose of the project is to provide the technical basis for the development of regulatory criteria to evaluate the safety implications of human factors associated with advanced I and C in nuclear power plants. During the first part of this project a survey of the US and Canadian utilities and vendors was conducted. The survey was oriented towards determining the human factors issues related to the current, planned, and potential future uses of digital systems in control rooms and technical support centers. The human factors issues were prioritized in regards to their importance by representatives from both ORNL and NRC.

32410 (NUREG/CP–0104, pp. 8.7-8.8) **The effects of local control station design variation on plant risk.** O'Hara, J. (Brookhaven National Lab., Upton, NY (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor

safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

The existence of human engineering deficiencies at local control stations (LCSs) was addressed in a study (NUREG/CR-3696) conducted by the Pacific Northwest Laboratory (PNL). PNL concluded that the existence of these human factors deficiencies at safety significant LCSs increases the potential for operator errors that could be detrimental to plant and public safety. However, PNL did not specific analysis to evaluate the effects of LCS design variations on human performance, on plant risk, or on the cost benefit feasibility of upgrading LCSs. The purpose of the present investigation was to conduct such an analysis. The specific objectives of the research were (1) to further define important local control stations, human factors related LCS design variations, and typical human engineering deficiencies (HEDs) at LCSs; (2) to determine the effect of LCS design variations on human performance, i.e., on risk-significant human errors (HEs); (3) to determine the effect of LCS-induced human performance variation on plant risk as measured by core melt frequency (CMF); and (4) to determine whether LCS improvements (upgrades in LCS design to mitigate HEDs) are feasible in a scoping-type value-impact analysis. The results can be summarized as follows. There was an overall effect of LCS variations on human performance. The transition from the worst LCS configuration to the best resulted in an absolute reduction or improvement of 0.82 in mean HEP (reduction by a factor of 20). The transition from low to high levels of FC was associated with a 0.46 (86%) reduction in mean HEP. The majority of the effect was accounted for in the transition from the low to medium levels. The Panel Design dimension also had an effect on human performance although not as large as functional centralization. Upgrading from a low to high panel design resulted in a 0.29 (69%) reduction in mean HEP.

32411 (NUREG/CP–0104, pp. 9.1-9.2) **Aging assessment of auxiliary feedwater systems.** Casada, D.A. (Oak Ridge National Lab., TN (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. DOE Contract AC05-84OR21400. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

A Phase I study of Auxiliary Feedwater (AFW) Systems has been conducted at Oak Ridge National Laboratory (ORNL) as a part of the Nuclear Regulatory Commission (NRC) Nuclear Plant Aging Research Program. This study has largely focused on two areas: (1) a review of historical failure data for AFW System components; (2) the detailed review of the AFW system design and operating practices at a plant owned by a cooperating utility. Historical failure data from the Institute of Nuclear Power Operations' Nuclear Plant Reliability Data System, S.M. Stoller's Nuclear Power Experience, and the NRC's Sequence Coding and Search System were combined to form a single AFW System failure database. The review of the failure database has identified that AFW pump drivers, including turbine, motor, and diesel drivers, have been historically the principal sources of AFW System degradation. Turbine drivers, in particular, have been a dominant single source of degradation for the AFW System. Failure of valve operators was also a significant source of system degradation. There were more failure records that were attributable to valve operators than any other component type (although the overall system degradation due to valve operator failures was less than that associated with pump drivers). The detailed review of AFW System design and operating practices at the plant owned by a cooperating utility was conducted primarily in order to assess the extent to which identifiable failure modes could be expected to be determined by current programmatic monitoring practices. During the review of monitoring procedures, an estimate of the number of test-related actuations of AFW System components was also made in order to provide an insight into the extent to which testing itself was involved in service wear.

32412 (NUREG/CP–0104, pp. 9.3-9.4) **Instrument air system - Aging impact on system availability.** Villaran, M. (Brookhaven National Lab., Upton, NY (USA)); Subudhi, M. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

As part of ongoing efforts to understand and manage the effects of aging in nuclear power plants, an aging assessment was performed for the Instrument Air (IA) system, a system that has been the subject of much scrutiny in recent years. Despite its non-safety classification, instrument air has been a factor in a number of potentially serious events. This report presents the results of the assessment and discusses the impact of instrument air system aging on system availability and plant safety. This work was performed for the US Nuclear Regulatory Commission (NRC) as part of the Nuclear Plant Aging Research (NPAR) program. To perform the complex task of analyzing an entire system, the Aging and Life Extension Assessment Program (ALEAP) System Level Plan was developed by Brookhaven National Laboratory and applied successfully in previous system aging studies. The work presented herein was performed using two parallel work paths, as described in the ALEAP plant. One path used deterministic techniques to assess the impact of aging on compressed air system performance, while the second path used probabilistic methods. Results from both paths then were used to characterize aging in the instrument air system. Some conclusions from this work are: compressors, air system valves, and air dryers were found to make up the majority of failures; the effectiveness and quantity of preventive maintenance devoted to a component significantly affected the amount of failures experienced; review of compressed air system designs and studies using a PRA-based system model revealed that the redundancy of key components (compressors, dryers, IA/SA cross-connect valve) was an important factor in system availability; total loss of air events are uncommon.

32413 (NUREG/CP–0104, pp. 9.7-9.8) **The use of NPAR [Nuclear Plant Aging Research] results in plant inspection activities.** Gunther, W. (Brookhaven National Lab., Upton, NY (USA)); Taylor, J. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

The Nuclear Plant Aging Research (NPAR) Program is a hardware oriented research program which has produced a large data base of equipment and system operating, maintenance, and testing information. A review of the NRC Inspection Program and discussions with NRC inspection personnel have revealed several areas where NPAR research results would be valuable to the inspector. This paper describes the NPAR information which can enhance inspection activities, and provides alternatives for making these pertinent research results available to the inspectors. The NRC Inspection Program emphasis is on evaluating the performance of licensees by focusing on requirements and standards associated with administrative, managerial, engineering, and operational aspects of licensee activities. The Program recognizes that licensees may satisfy NRC requirements differently, and therefore expresses inspection guidance in the form of performance objectives and evaluation criteria. for the resident and regional inspectors, procedures have been written covering various subject areas, such as operations, maintenance, and surveillance. Some of these procedures contain guidance related to aging degradation. The types of information generated by NPAR which were found to be relevant to inspection needs include the following: functional indicators; failure modes, causes, effects; stresses which cause degradation; maintenance recommendations; inspection prioritization. 3 refs.

32414 (NUREG/CR–4550-Vol.3-Rev.1-Pt.1) **Analysis of core damage frequency: Surry, Unit 1 internal events: Volume 3, Revision 1, Part 1.** Bertucio, R.C. (E.I. Services, Kent, WA (USA)); Julius, J.A.; Cramond, W.R. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 461p. Sponsored

by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (SAND–86-2084-Vol.3-Rev.1-Pt.1). Available from NTIS, PC A20/MF A01 - GPO; OSTI; INIS.

This document contains the accident sequence analysis of internally initiated events for the Surry Nuclear Station, Unit 1. This is one of the five plant analyses conducted as part of the NUREG-1150 effort by the Nuclear Regulatory Commission. NUREG-1150 documents the risk of a selected group of nuclear power plants. The work performed and described here is an extensive of that published in November 1986 as NUREG/CR-4450, Volume 3. It addresses comments form numerous reviewers and significant changes to the plant systems and procedures made since the first report. The uncertainty analysis and presentation of results are also much improved. The context and detail of this report are directed toward PRA practitioners who need to know how the work was performed and the details for use in further studies. The mean core damage frequency at Surry was calculated to be 4.05-E-5 per year, with a 95% upper bound of 1.34E-4 and 5% lower bound of 6.8E-6 per year. Station blackout type accidents (loss of all AC power) were the largest contributors to the core damage frequency, accounting for approximately 68% of the total. The next type of dominant contributors were Loss of Coolant Accidents (LOCAs). These sequences account for 15% of core damage frequency. No other type of sequence accounts for more than 10% of core damage frequency. 49 refs., 52 figs., 70 tabs.

32415 (NUREG/CR–4550-Vol.3-Rev.1-Pt.2) **Analysis of core damage frequency, Surry, Unit 1 internal events appendices: Volume 3, Revision 1, Part 2.** Bertucio, R.C. (E.I. Services, Kent, WA (USA)); Julius, J.A.; Cramond, W.R. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 703p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (SAND–86-2084-Vol.3-Rev.1-Pt.2). Available from NTIS, PC A99/MF A01 - GPO; OSTI; INIS.

This document contains the appendices for the accident sequence analyses of internally initiated events for the Surry Nuclear Station, Unit 1. This is one of the five plant analyses conducted as part of the NUREG-1150 effort by the Nuclear Regulatory Commission. NUREG-1150 documents the risk of a selected group of nuclear power plants. The work performed is an extensive reanalysis of that published in November 1986 as NUREG/CR-4450, Volume 3. It addresses comments from numerous reviewers and significant changes to the plant systems and procedures made since the first report. The uncertainty analysis and presentation of results are also much improved. The context and detail of this report are directed toward PRA practitioners who need to know how the work was performed and the details for use in further studies. The mean core damage frequency at Surry was calculated to be 4.0E-5 per year, with a 95% upper bound of 1.3E-4 and 5% lower bound of 6.8E-6 per year. Station blackout type accidents (loss of all AC power) were the largest contributors to the core damage frequency, accounting for approximately 68% of the total. The next type of dominant contributors were Loss of Coolant Accidents (LOCAs). These sequences account for 15% of core damage frequency. No other type of sequence accounts for more than 10% of core damage frequency.

32416 (NUREG/CR–4639-Vol.1-Rev.1) **Nuclear Computerized Library for Assessing Reactor Reliability (NUCLARR): Summary description: Volume 1, Revision 1.** Gertman, D.I. (EG and G Idaho, Inc., Idaho Falls, ID (USA)); Gilmore, W.E.; Galyean, W.J.; Groh, M.R.; Gentillon, C.D.; Gilbert, B.G.; Reece, W.J. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; EG and G Idaho, Inc., Idaho Falls, ID (USA). May 1990. 19p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. (EGG–2458-Vol.1-Rev.1). Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

The Nuclear Computerized Library for Assessing Reactor Reliability (NUCLARR) is an automate data base management system for storing and processing human error probability and hardware component failure rate data. The NUCLARR system software resides on an IBM (or compatible) personal microcomputer. NUCLARR can be accessed by the end user to furnish data suitable for input in human and/or hardware reliability analysis to support a variety of risk assessment activities. The NUCLARR system is documented in a five-volume series of reports. This document Volume 1, of this series is the Summary Description, which presents an overview of the data management system, including a description of data collection, data qualification, data structure, and taxonomies. Programming activities, procedures for processing data, a user's guide, and hard copy data manual are presented in Volumes 2 through 5, NUREG/CR-4639.

32417 (NUREG/CR–5253) **PARTITION: A program for defining the source term/consequence analysis interface in the NUREG–1150 probabilistic risk assessments: User's guide.** Iman, R.L. (Sandia National Labs., Albuquerque, NM (USA)); Helton, J.C.; Johnson, J.D. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; Sandia National Labs., Albuquerque, NM (USA). May 1990. 49p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (SAND–88-2940). Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

The individual plant analyses in the US Nuclear Regulatory Commission's reassessment of the risk from commercial nuclear power plants (NUREG-1150) consist of four parts: systems analysis, accident progression analysis, source term analysis, and consequence analysis. Careful definition of the interfaces between these parts is necessary for both information flow and computational efficiency. This document has been designed for users of the PARTITION computer program developed by the authors at Sandia National Laboratories for defining the interface between the source term analysis (performed with the XXSOR programs) and the consequence analysis (performed with the MACCS program). This report provides a tutorial that details how the interactive partitioning is performed, along with detailed information on the partitioning process. The PARTITION program was written in ANSI standard FORTRAN 77 to make the code as machine-independent (i.e., portable) as possible. 9 refs., 4 figs.

32418 (NUREG/CR–5262) **PRAMIS: Probability Risk Assessment Model Integration System: User's guide.** Iman, R.L. (Sandia National Labs., Albuquerque, NM (USA)); Johnson, J.D.; Helton, J.C. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; Sandia National Labs., Albuquerque, NM (USA). May 1990. 75p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (SAND–88-3093). Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

This document has been designed for users of the Probabilistic Risk Assessment Model Integration System (PRAMIS) computer developed by the authors at Sandia National Laboratories for easy assembly of the individual parts of the NUREG-1150 plant analyses into overall risk results. PRAMIS assembles the following files associated with the NUREG-1150 analyses in matrix format to obtain risk: the Latin hypercube sample, the results of the systems analysis, the results of the accident progression analysis, the results of the source term/partitioning analysis, and the results of the consequence analysis. In addition, various intermediate and conditional quantities are calculated when requested by user-specified input; the fractional contribution to risk of individual plant damage states, accident progression bins and source term groups are determined, and a file containing the original Latin hypercube sample and user-specified dependent variables is generated for use as input to the SAS statistical package. This report provides a tutorial that details how to use the PRAMIS program. The PRAMIS program is written in ANSI standard FORTRAN 77 to make the code as machine-independent as possible.

32419 (NUREG/CR–5397) **Value-impact analysis of regulatory options for resolution of Generic Issue C-8: MSIV [Main Steam Isolation Valve] leakage and LCS [Leakage Control System] failure.** Jamison, J.D. (Pacific Northwest Lab., Richland, WA (USA)); Vo, T.V.; Tabatabai, A.S. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Safety Issue Resolution; Pacific Northwest Lab., Richland, WA (USA). May 1990. 93p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC06-76RL01830. (PNL–6931). Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

This report describes the analysis conducted to establish the basis for answering two remaining regulatory questions facing the

NRC staff regarding the resolution of Generic Issue C-8, specifically:(1) What action should the NRC take concerning plants that currently have a leakage control system (LCS)? and, (2) What action should the NRC take concerning plants that do not have an LCS? Using individual MSIV leak test data, the performance of a system of eight such valves in a standard BWR con-figuration was modeled. The performance model was used along with estimates of core damage accident frequency and calculated dose consequences to determine the public risk associated with each of the alternatives. The occupational exposure implications of each alternative were calculated using estimates of labor hours in radiation zones that would be incurred or avoided. The costs to industry of implementing each alternative were estimated using standard cost formulae and NRC staff estimates. The cost to the NRC were estimated based on the effort incurred or avoided for reviews or other staff actions engendered by the selection of or avoided for reviews or other staff actions engendered by the selection of a particular alternative. The cost and risks thus calculated suggest that no regulatory action can be justified on the basis of risk reduction or cost savings. 12 refs., 1 tab.

32420 (NUREG/CR–5436-Vol.1) **The development and evaluation of programmatic performance indicators associated with maintenance at nuclear power plants: Main report: Volume 1.** Wreathall, J. (Science Applications International Corp., Columbus, OH (USA)); Fragola, J.; Appignani, P.; Burlile, G.; Shen, Y. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Science Applications International Corp., Columbus, OH (USA). May 1990. 115p. Sponsored by Nuclear Regulatory Commission. (SAIC–90/1130-Vol.1). Available from NTIS, PC A07/MF A01 - GPO; OSTI; INIS.

This report summarizes the development and evaluation of programmatic performance indicators of maintenance. These indicators were selected by: (1) creating a formal framework of plant processes; (2) identifying features of plant behavior considered important to safety; (3) evaluating existing indicators against these features; and (4) performing statistical analyses for the selected indicators. The report recommends additional testing. 32 refs., 29 figs., 11 tabs.

32421 (NUREG/CR–5436-Vol.2) **The development and evaluation of programmatic performance indicators associated with maintenance at nuclear power plants: Appendices: Volume 2.** Wreathall, J. (Science Applications International Corp., Columbus, OH (USA)); Fragola, J.; Appignani, P.; Burlile, G.; Shen, Y. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Science Applications International Corp., Columbus, OH (USA). May 1990. 223p. Sponsored by Nuclear Regulatory Commission. (SAIC–90/1130-Vol.2). Available from NTIS, PC A10/MF A01 - GPO; OSTI; INIS.

This report summarizes the development and evaluation of programmatic performance indicators of maintenance. These indicators were selected by: (1) creating a formal framework of plant processes; (2) identifying features of plant behavior considered important to safety; (3) evaluating existing indicators against these features; and (4) performing statistical analyses for the selected indicators. The report recommends additional testing. This document provides the appendices to the report. These appendices are: synopsis of process model; detailed results of statistical analysis; and signal processing analysis of daily power loss indicator.

32422 (NUREG/CR–5557) **RELAP5 thermal-hydraulic analysis of the SNUPPS [Standardized Nuclear Unit Power Plant System] pressurized water reactor.** Kullberg, C.M. (EG and G Idaho, Inc., Idaho Falls, ID (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; EG and G Idaho, Inc., Idaho Falls, ID (USA). May 1990. 83p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. (EGG–2599). Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

Thermal-hydraulic analyses of five hypothetical accident scenarios were performed with the RELAP5 computer code for the Westinghouse Standardized Nuclear Unit Power Plant System pressurized water reactor. This work was sponsored by the US Nuclear Regulatory Commission and is being done in conjunction with future analysis work at the US Nuclear Regulatory Commission Technical Training Center in Chattanooga, TN. These accident scenarios were chosen to asses and benchmark the thermal-hydraulic capabilities of the Technical Training Center Standardized Nuclear Unit Power Plant System simulator to model abnormal transient conditions. 5 refs., 50 figs., 8 tabs.

32423 (NUREG/IA–0023-Vol.1) **Assessment of TRAC-PF1/MOD1 version 14.3 using separate effects critical flow and blowdown experiments: Volume 1, Test and tables.** Spindler, B. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France)); Pellissier, M. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Jan 1990. 139p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A07/MF A01 - GPO; OSTI; INIS.

Independent assessment of the TRAC code was conducted at the Centre d'Etudes Nucleaires de Grenoble of the Commissariate a l'Energie Atomique (France) in the frame of the ICAP. This report presents the results of the assessment of TRAC-PF1/MOD1 version 14.3 using critical flow steady state tests (MOBY-DICK, SUPER-MOBY-DICK), and blowdown tests (CANON, SUPER-CANON, VERTICAL-CANON, MARVIKEN, OMEGA-TUBE, OMEGA-BUNDLE). This document, Volume 1, presents the text and tables from this assessment.

32424 (NUREG/IA–0023-Vol.2) **Assessment of TRAC-PF1/MOD1 Version 14.3 using separate effects critical flow and blowdown experiments: Volume 2, Figures.** Spindler, B. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France)); Pellissier, M. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Jan 1990. 231p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A11/MF A01 - GPO; OSTI; INIS.

Independent assessment of the TRAC code was conducted at the Centre d'Etudes Nucleaires de Grenoble of the Commissariate a l'Energie Atomique (France) in the frame of the ICAP. This report presents the results of the assessment of TRAC-PF1/MOD1 version 14.3 using critical flow steady state tests (MOBY-DICK, SUPER-MOBY-DICK), and blowdown tests (CANON, SUPER-CANON, VERTICAL-CANON, MARVIKEN, OMEGA-TUBE, OMEGA-BUNDLE). This document, Volume 2, presents the experimental data and figures from the assessment.

32425 (PB–90-861857/XAB) **Fault tree analysis of nuclear power plant components and systems. January 1976-December 1989 (a Bibliography from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for January 1976-December 1989.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 56p. Available from NTISPC N01/MF N01.

Supersedes PB–87-854410.

This bibliography contains citations concerning risk assessment, reliability analysis, failure analysis, and safety studies of nuclear power plant components and systems using fault tree analysis methods. Faults caused by components, human error, environmental considerations, and common mode failures are presented. Various systems and components are analyzed, including high pressure safety injection, auxiliary feedwater, instrumentation, emergency core flooding and cooling, and steam generator tubing. (This updated bibliography contains 95 citations, 39 of which are new entries to the previous edition.)

32426 **Melt propagation in dry core debris beds.** Dosanjh, S.S. (Sandia National Labs., Reactor Safety Theoretical Physics, Albuquerque, NM (US)). *Nuclear Technology (USA),* 88(1): 30-46 (Oct 1989). DOE Contract AC04-76DP00789.

During severe light water reactor accidents like Three Mile Island Unit 2, the fuel rods can fragment and thus convert the reactor core into a large particle bed. The postdryout meltdown of such debris beds is examined. A two-dimensional model that considers the presence of oxidic (UO_2 and ZrO_2) as well as metallic (e.g., zirconium) constituents is developed. Key results are that a dense metallic crust is created near the bottom of the bed as molten materials flow downward and freeze; liquid accumulates above the blockage and, if zirconium is present, the pool grows rapidly as

molten zirconium dissolved both UO_2 and ZrO_2 particles; if the melt wets the solid, a fraction of the melt flows radially outward under the action of capillary forces and freezes near the radial boundary; in a nonwetting system, all of the melt flows into the bottom of the bed; and when zirconium and iron are in intimate contact and the zirconium metal atomic fraction is > 0.33, these metals can liquefy and flow out of the bed very early in the meltdown sequence.

32427 **Trends versus reactor size of passive reactivity shutdown and control performance.** Wade, D.C. (Argonne National Lab., IL (USA). Engineering Div.); Fujita, E.K. *Nuclear Science and Engineering (USA),* 103(2): 182-195 (Oct 1989).

Favorable passive reactivity shutdown performance in response to unprotected accident initiators has been shown to be achievable when several measurable, integral reactivity parameters related to the power, flow, and inlet temperature coefficients of reactivity satisfy certain simple constraints among their dimensionless ratios. The trends in these dimensionless ratios with reactor size for both oxide- and metal-fueled cores have been developed, based on a data base of ~ 24 reactor designs in the range from 400 to 3600 MW (thermal). Based on the trends, the authors conclude that the favorable passive reactivity shutdown features that accrue to the metallic-fueled reactors in the modular-size range can be achieved as well in the larger commercial sizes.

32428 **Critical experiment tests of bowing and expansion reactivity calculations for liquid-metal-cooled fast reactors.** Schaefer, R.W. (Argonne National Lab., IL (USA). Engineering Div.). *Nuclear Science and Engineering (USA),* 103(2): 196-209 (Oct 1989). DOE Contract W-31-109-ENG-38.

Experiments done in several critical assemblies of the liquid-metal-cooled fast reactor type are reported. They simulated core axial expansion, core radial expansion and bowing, coolant expansion, and control driveline expansion. For the most part, new experimental techniques were developed to perform these experiments. Calculations of the experiments basically used design-level methods except when it was necessary to investigate complexities peculiar to the experiments. It was found that these feedback reactivities generally are overpredicted, but the predictions are within 30% of the experimental values.

24 POWER TRANSMISSION AND DISTRIBUTION

2401 Power Systems

32429 (CONF-9005172–1) **Impact of automated feeder reconfiguration on capacity utilization at the Athens Utilities Board.** Lawler, J.S. (Tennessee Univ., Knoxville, TN (USA). Dept. of Electrical and Computer Engineering); Rizy, D.T.; Stovall, J.P.; Patton, J.B.; Fortson, N.H. Oak Ridge National Lab., TN (USA). [1990]. 8p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From 21. annual conference on modeling and simulation; Pittsburgh, PA (USA); 3-4 May 1990. Order Number DE90010710. Available from NTIS, PC A02/MF A01 - OSTI.

This paper discusses experiments conducted on the Athens Utilities Board and simulations that were performed to evaluate the capacity utilization benefits of automation. The primary benefits of loss and peak load reduction are not realized on the AUB system. The characteristics of the AUB system which preclude achieving these benefits are discussed. 4 refs., 6 figs., 2 tabs.

32430 (EPRI-P–6060-CCM) **The BENCHMARK™ code: Simulation of hourly generation: User's guide.** Jenkins, R.T. (Tennessee Univ., Chattanooga, TN (USA). School of Engineering). Electric Power Research Inst., Palo Alto, CA (USA); Tennessee Univ., Chattanooga, TN (USA). School of Engineering. c Apr 1990. 242p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

BENCHMARK simulates generator commitment and dispatch hourly for periods extending from one week to one year. Its value to utilities stems from its accurate representation of operator strategies and generator operating constraints (including ramp rate limits, minimum operating levels, and minimum uptime and downtime). The availability of thermal units is either prespecified or determined by a Monte Carlo technique. The program can model a pumpstorage or compressed-air energy storage facility, and can allocate hydroelectric energy over a multiweek interval. BENCHMARK can produce reports with detailed hourly data or summary reports for part or all of the simulation period. Results can be reported for individual units or for groups of units. It is also possible to produce a file of data for use with an external graphics program. BENCHMARK is written in FORTRAN and requires about 2-1/2 megabytes of core. Execution times per simulation week and per Monte Carlo replication vary from under 1 second of CPU time for systems without a storage facility to up to about 10 seconds for a large system with pumped storage.

32431 **An oscillation detector used in the BPA power system disturbance monitor.** Haver, J.F. (Bonneville Power Administration, Portland, OR (USA)); Vakili, F. *IEEE Transactions on Power Systems (Institute of Electrical and Electronics Engineers) (USA),* 5(1): 74-79 (Feb 1990).

In 1987 an oscillation trigger was developed for the power system disturbance monitor that the Bonneville Power Administration (BPA) operates at the Dittmer Control Center. The trigger logic resembles that for extracting information from an amplitude-modulated carrier wave. Operating experience shows the trigger to be sensitive, reliable, and versatile. This paper describes the trigger and its basic principles in detail. Filter responses curves and FORTRAN source code are provided for use by utilities having similar needs.

32432 **Initial results in prony analysis of power system response signals.** Haver, J.F. (Bonneville Power Administration, Portland, OR (USA)); Demeure, C.J.; Schart, L.L. *IEEE Transactions on Power Systems (Institute of Electrical and Electronics Engineers) (USA),* 5(1): 80-89 (Feb 1990).

Prony analysis is an emerging methodology that extends Fourier analysis by directly estimating the frequency, damping, strength, and relative phase of modal components present in a given signal. The ability to extract such information from transient stability program simulations and from large-scale system tests or disturbances would be quite valuable to power system engineers. This paper reports early results in the application of this method to stability program output. It also includes benchmarks against known models and a brief mathematical summary.

2402 Power System Networks, Transmission and Distribution

Refer also to citation(s) 32429, 32434, 32436

32433 **Power-transmission device.** Otto, W.F.; Holloman, M.E.; Jordan, D. To Department of the Air Force, Washington, DC. USA Patent Application 7-456,899. 26 Dec 1989. 9p. Available from NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

A power-transmission device for transmitting electric power optically to remote locations is disclosed. The device includes a laser for generating a laser light beam and an optical glass monofilament having a glass core and an outer cladding layer designed to convey the light beams directed into one end of said monofilament to the other end thereof. Means are provided for directing the laser beam into the receiving end for the monofilament at a predetermined angle which causes the light beam to exit from the other end of the monofilament at the same predetermined angle in a conical annulus of light. A conical reflector is disposed within the conical annulus of light exiting from the exit end of the fiber optical monofilament and has surfaces that intercepts the light beams within the conical annulus and reflects them along a different path. Disposed around the conical reflector is a plurality of photovoltaic cells in a position to intercept the reflected light beams and to convert the light beams to electric current. The photovoltaic cells are connected in series to increase the amount of voltage produced by the transmission device. Patent applications. (SDW)

2403 Power Transmission Lines and Cables

Refer also to citation(s) 32878

32434 (CONF-900773–1) **The response of MOV and SiC arresters to steep-front longer duration current pulses.** Miller, D.B. (Mississippi State Univ., Mississippi State, MS (USA)); Fan, Hong Bo; Barnes, P.R. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From IEEE/PES 1990 summer meeting; Minneapolis, MN (USA); 15-20 Jul 1990. Order Number DE90008572. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An 80 m section of 138 kV transmission cable is used to produce pulses with voltages of several hundred kilovolts, currents greater than 20,000 A and risetimes equal to approximately 50 ns. This line pulser is used to test the response of MOV and gapped SiC surge arresters to steep-front, high current, 1.4 microsecond duration pulses. The typical arrester voltage during a pulse consists of a very strong initial "overshoot" voltage spike, followed by a nearly constant "residual" voltage which lasts to the end of the pulse. The "overshoot" voltage is believed to be related to the inductance of the arrester/divider circuit; this voltage increases linearly with peak current and is about the same for the MOV and SiC arresters. The "residual" voltage indicates the protection offered by the arrester due to its voltage clamping action and is larger for the SiC arrester. Replacing the arrester by a similarly sized aluminum tube allows the inductive portion of the response to be removed, and the true arrester response is then seen to be quite fast. 3 refs., 12 figs.

2404 Health and Safety

Refer also to citation(s) 33259

32435 (DOE/RA/50219–T10) **Investigation of effects of 60-Hz electric and magnetic fields on operant and social behavior and on the neuroendocrine system of nonhuman primates: Annual report.** Orr, J.L. Southwest Research Inst., San Antonio, TX (USA). Oct 1989. 88p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-80RA50219. (SwRI–12-6253). Order Number DE90010809. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The objective of this program is to investigate, using the baboon as a nonhuman primate surrogate for the human, behavioral and neuroendocrine effects associated with exposure to 60-Hz electric and magnetic fields. Results from this program could be used to estimate and evaluate the likelihood of deleterious consequences resulting from exposure of humans to the electric and magnetic fields associated with electric power transmission. This program is being conducted at Southwest Research Institute (SwRI) as part of an international collaborative information exchange and scientific research effort. This annual report marks the completion of the first year of the four year research program. This project year has focused on two technical areas: the modification of the facility to include 60-Hz magnetic fields, and development of the capability for studies of neuroendocrine parameters by obtaining blood samples from baboons during electric and magnetic field exposure. Activities in the social behavior, operant behavior, and laboratory animal sciences during this project year have been in preparation for the start of Experiment 3. 7 figs., 10 tabs.

2407 Economic, Industrial, and Business Aspects

32436 (NRRI–90-5) **Reliability differentiated pricing of electricity service.** Rau, N.S.; Hegazy, Y. National Regulatory Research Inst., Columbus, OH (USA). Mar 1990. 120p. Available from OSTI; National Regulatory Research Institute, 1080 Carmack Road, Columbus, OH 43210.

It has been suggested that electricity customers be given the choice of opting for different levels of service reliability. Customers would then subscribe to level of reliability that best suits them and their processes. Such a choice would unbundle the service. Implicit in the suggestion is the assumption that in the long run, unbundle service improves the lots of both customers and producers. In other words, reliability differentiated service improves efficiency. The purpose of this study is two-fold. First, we examine the practicality of implementing reliability differentiated service. Second we compare economic welfare measurements as they pertain to reliability-based prices and other methods for setting the prices for electricity services. In essence, the reliability-based prices present customers with the prospect of electing to pay a particular price for a specific service reliability. However, these prices are not optimal in the sense they cause the maximization of consumer plus producer surpluses in a regulated environment. Instead, these prices are constrained by hour-specific revenue requirements for two customer classes. Hence, they are not efficient prices although they possess the potential to increase economic welfare when compared to other economically suboptimal regulated prices. 27 refs., 19 figs., 13 tabs.

25 ENERGY STORAGE

2502 Compressed and Liquefied Gas

Refer also to citation(s) 32430

2506 Thermal

Refer also to citation(s) 32440, 32490

2508 Chemical

32437 (SAND–90-0005C) **Titanium-boron mixtures as variable heat sources.** Begeal, D.R. (Sandia National Labs., Albuquerque, NM (USA)); Munger, A.C. Sandia National Labs., Albuquerque, NM (USA). [1990]. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900792–2: 15. international pyrotechnics seminar, Boulder, CO (USA), 9-13 Jul 1990). Order Number DE90009729. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The reaction between titanium and boron to form titanium diboride is one of the hottest pyrotechnic reactions in common usage and offers the advantage of being a solid state gasless reaction. Based on the work of Hart, a heat source with a variable output has been developed that utilizes this pyrotechnic. The device was designed to deliver the heat across a 0.26 inch inner diameter hemispherical bulkhead of a material and thickness that can be specified by the user. For evaluation purposes, the bulkhead was 0.036 inches thick stainless steel. The maximum temperature on the tip of the bulkhead was 950°C for the pure reactants and 680°C for blends diluted with 30 weight percent of alumina. Further, the temperature was uniform within ±20°C across a 2 millimeter diameter on the tip of the bulkhead, and the temperature rise characteristics were repeatable. Ignition of the titanium/boron heat powder was accomplished by first igniting an adjacent charge of titanium subhydride/potassium perchlorate with a one ohm bridge wire. The header was constructed of inconel, a glass ceramic insulator, and hastelloy pins. The ignition and subsequent burn of the titanium/boron was nearly instantaneous, thus the thermal output was dependent only on the heat transfer properties of the materials and geometry involved. Therefore, the user can tailor the blend dilution and the bulkhead characteristics to provide a large range of precise heat outputs. Typical uses of this heat source include timely ignition of other materials, or heating confined gas to perform useful mechanical work. Achievement of the precise heat output required special attention to the purity of the titanium and boron and to the blending process. These aspects, as well as those described above will be described. 6 refs., 9 figs., 3 tabs.

2509 Batteries

Refer also to citation(s) 32523

32438 (EGG-EP–8919) **Laboratory testing of chloride 3ET205 6 volt traction battery.** Hardin, J.E. EG and G Idaho, Inc., Idaho Falls, ID (USA). Oct 1989. 24p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order

Number DE90010926. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The purpose of this report is to describe the testing performed on the Chloride 3ET205 6 volt traction batery by the INEL Battery Laboratory, to present the results and conclusions of this testing, and to make appropriate recommendations. The Chloride 3ET205 is a tubular plate lead-acid battery made in England by the Chloride Battery Company and imported into the US. The traction battery division of Chloride has been sold, although Chloride assured its customers that the 3ET205 would continue to be available for their consumption. The new owners of the factory are Tudor and Fulman of France. The joint venture company name is C. E. Ac. It is our understanding that all orders are to be sent to the factory at Salford Rd., Bolton, Lancashire, England BL5 1DD. 5 refs., 13 figs., 4 tabs.

32439 (EGG-EP–8954) **Initial testing of two DEMI [Driesbach Electromotive Inc.] Model 4E zinc-air rechargeable cells.** Hardin, J.E.; Martin, M.E. EG and G Idaho, Inc., Idaho Falls, ID (USA). 23 Oct 1989. 18p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90010927. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The purpose of this document is to report the results of INEL laboratory testing of two DEMI 4E Aerobic Power Battery Cells (collectively designated Pack 46 in INEL records). The 4E Aerobic Power Battery is a secondary battery developed privately by Driesbach Electromotive Inc. (DEMI). The battery employs zinc as the anode and a bifunctional air cathode. This testing was performed as the first phase of a cooperative agreement between INEL and DEMI leading to the construction and testing of electric vehicle-size cells, to be followed eventually by a battery pack. 3 refs., 3 figs., 5 tabs.

32440 (SAND–89-2229C) **Self-discharge study of Li-alloy/FeS_2 thermal cells.** Guidotti, R.A. (Sandia National Labs., Albuquerque, NM (USA)); Reinhardt, F.W.; Smaga, J.A. Sandia National Labs., Albuquerque, NM (USA). [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. (CONF-9006146–4: 34. international power sources symposium, Cherry Hill, NJ (USA), 25-28 Jun 1990). Order Number DE90010659. Available from NTIS, PC A02/MF A01 - OSTI.

The capacities of Li-alloy/FeS_2thermal batteries are influenced by the extent of self-discharge reactions that occur during operation. For some thermal-battery applications involving open-circuit (i.e., "wet-stand") conditions, this self-discharge can result in a significant loss incapacity. A study was undertaken to obtain a better understanding of the factors influencing the self-discharge of thermal cells, such as temperature, electrolyte composition, and processing of the catholyte (i.e., lithiation and fusion). The cells were discharged after prescribed times at open circuit under isothermal conditions and the capacity to a cutoff voltage was measured. Postmortem characterization of the cells was used to correlate the results of the electrochemical experiments. 4 refs., 8 figs., 1 tab.

32441 (SAND–89-2342C) **Resistivity measurements of halide-salt/MgO separators for thermal cells.** Redey, L. (Argonne National Lab., IL (USA)); McParland, M.; Guidotti, R. Sandia National Labs., Albuquerque, NM (USA). [1990]. 5p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. (CONF-9006146–5: 34. international power sources symposium, Cherry Hill, NJ (USA), 25-28 Jun 1990). Order Number DE90009740. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Resistivities of 20 compositions of halide-salt/MgO mixtures (various selections and percentages of LiF, LiCl, LiBr, KCl, KBr, CsBr, and MgO) to be used in Li-alloy/metal sulfide cells have been measured at temperatures between the melting point of a particular mixture and 500°C. The resistivities were determined with cold-pressed electrolyte-binder pellets by using a special cell and DC measuring technique. Temperature, salt composition, and MgO content were found to have a strong influence on resistivity. These factors are listed in decreasing order of the magnitude of the effect. The fabrication density (porosity) of the pellet also has some effect on resistivity. These measured resistivities provide a data base to select optimum compositions of electrolyte-binder pellets for LiSi/FeS_2 thermal batteries and to calculate area-specific resistances of these components for battery modeling and optimization. 5 refs., 7 figs.

29 ENERGY PLANNING AND POLICY

2902 Economics and Sociology

Refer also to citation(s) 32219, 32220, 32459, 32461, 32464, 32469, 32502, 32959, 33126

2903 Environment, Health, and Safety

Refer also to citation(s) 32151, 32154, 32349, 32506, 32510, 32512, 32959, 32960, 33066, 33079, 33080, 33082, 33094, 33095, 33106, 33126, 33141, 33153, 33154, 33155, 33156, 33157, 33158, 33159, 33160, 33161, 33162, 33163, 33165, 33178, 33179, 33246

32442 (CONF-9004182–1) **The AFLC ECAMP [Environmental Compliance Assessment and Management Program] experience: How it was done and lessons learned.** Walker, T.J. (Air Force Logistics Command, Wright-Patterson AFB, OH (USA)); Levenson, J.B. Argonne National Lab., IL (USA). [1990]. 5p. Sponsored by U.S. Department of Defense. DOE Contract W-31109-ENG-38. From 17. environmental symposium: environmental compliance and enforcement at DOD installations in the 1990's; Atlanta, GA (USA); 17-20 Apr 1990. Order Number DE90010099. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The US Air Force established the Environmental Compliance Assessment and Management Program (ECAMP) to enhance and ensure Air Force compliance with federal, state, and local environmental statutes, as well as with DOD and USAF policies and regulations. The cornerstone of ECAMP is a thorough, on-site facility inspection and records review for each of ten environmental programmatic areas. This paper describes Headquarters Air Force Logistics Command's (HQ AFLC) approach to implementing its first round of external ECAMP evaluations. Emphasis is placed on the "lessons learned" and action plan for future ECAMP evaluations.

32443 (LP/RB–88-15E) **Major chemical accidents: Are we prepared?.** Current issue review. Milke, R. (Science and Technology Div., Canada Library of Parliament, Ottawa, ON (Canada)). Canada Library of Parliament, Ottawa, ON (Canada). Research Branch. 18 Apr 1989. 32p. (MICROLOG–90-01842). Available from PC Library of Parliament of Canada, Parliament Buildings, Ottawa, ON, CAN K1A 0A9; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $3.50 CAN; MF $10 CAN.

The results of an assessment into the adequacy of existing measures to prevent and respond to major industrial accidents in the petroleum and chemical industry in Canada is reported. The oil and gas production sector risk exists primarily in the drilling operations where unexpected releases of H_2S may occur. Hazards in pipelines and gas plants are somewhat less because they can be anticipated and controlled. Petroleum refineries in urban areas present a potential for major accidents in the form of fire and explosion. Current government initiatives in risk control are also evaluated including legislation and regulation in the area of risk assessment, accident reporting, and accident prevention. The efforts of private enterprise in risk control are also described and evaluated. Response mechanisms such as contingency planning and the use of buffer zones are described, as well as the establishment of the Major Industrial Accidents Coordinating Committee which has a mandate to assess cordination of risk control and emergency response among various levels of government and industry. 4 refs.

32444 (PB–90-164666/XAB) **Management of hazardous and environmentally sensitive materials. Final report.** Price, R.L.; Paff, S.W. Pittsburgh Univ., PA (USA). Center for Hazardous Materials Research. 19 Dec 1989. 267p. Available from NTIS, PC A12/MF A02.

Portions of this document are not fully legible.

The proper management of hazardous and environmentally sensitive materials in Pennsylvania is governed by a large, complex,

and ever changing set of both Federal and State requirements. This complicated set of regulations and the constantly evolving nature pose a continuing and growing problem for government agencies like the Pennsylvania Department of Transportation (PennDOT) which must take steps to ensure that its employees maintain an accurate understanding of all regulatory requirements applying to the materials it uses. Information is provided on: the advantages of waste reduction and how to get started on a waste reduction program; requirements regarding the purchase, storage, use and transportation of hazardous materials; regulatory requirements for hazardous waste management; definition of a residual waste, and how residual wastes should be handled; typical sources of wastewater and regulations governing it's discharge; Preparedness, Prevention and Contingency (PPC) Planning; specific guidance for management of particular materials at PennDOT operations; and sources for more information.

32445 (PB–90-179656/XAB) **Stabilization/solidification of CERCLA and RCRA wastes: Physical tests, chemical testing procedures, technology screening, and field activities.** Environmental Protection Agency, Cincinnati, OH (USA). Center for Environmental Research Information. May 1989. 82p. (EPA–625/6-89/022). Available from NTIS, PC A05/MF A01.

Also available from Supt. of Docs.

The primary purpose of the handbook is to provide the U.S. Environmental Protection Agency (EPA) regional staff responsible for reviewing CERCLA remedial action plans and RCRA permit applications with a tool for interpreting information on stabilization/solidification treatment. As a practical day-to-day reference guide, it will provide the EPA staff and others with a quick update on particular aspects of stabilization/solidification. It also contains more detailed information on specific subjects and a complete list of recent references. In general, the handbook should prove useful to all technical and professional people working in the stabilization/solidification field, including State environmental protection agencies, private industry, commercial treatment and disposal facilities, and environmental consultants.

32446 (PB–90-187436/XAB) **Environmental trends. Council on Environmental Quality.** Council on Environmental Quality, Washington, DC (USA). 1989. 155p. Available from NTIS, PC A08/MF A01.

Also available from Supt. of Docs.

The sourcebook contains 367 graphics, most of which are computer generated and indicate current conditions and trends in the environment of the United States. The statistical series was compiled from data available through government agencies, private studies, or the literature of each discipline. The data were reviewed and verified by experts at various federal agencies. National data are used wherever possible, with breakdowns shown when especially meaningful. The text is drawn from the published sources cited. The report consists of nine chapters: minerals and energy, water, climate and air quality, land resources, wetlands and wildlife, protected areas, population, transportation, and environmental risks and hazards.

32447 (PB–90-188749/XAB) **Federal-facilities Hazardous-Waste Compliance Manual. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste and Emergency Response. 9 Jan 1990. 780p. (OSWER-DIRECTIVE–9992.4). Available from NTIS, PC A99/MF E06.

In the continuing effort to achieve a higher level of compliance with the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) at Federal facilities, the Federal Facilities Hazardous Waste Compliance Office (FFHWCO) has developed the Federal Facilities Hazardous Waste Compliance Manual. The manual includes an overview of the Federal-facilities hazardous-waste compliance program, relevant statutory authorities, model provisions for Federal facility agreements, enforcement and other applicable guidance, Federal facilities docket and NPL listings, data-management information, selected DOD and DOE program guidance, and organization charts and contacts. This compendium is intended to be used as a reference by Regional RCRA and CERCLA enforcement personnel and Regional Counsels, particularly as an orientation guide for new Federal facilities staff.

32448 (PB–90-191545/XAB) **Guidelines for effective management of the Contract Laboratory Program. Part 1. Contract award. Part 2. Contract administration.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. Nov 1989. 346p. (OERR–9240.0-04-1). Available from NTIS, PC A15/MF A02.

Internal guidelines are provided for Superfund Project Officers in procuring, administering, managing CLP contracts.

32449 (PB–90-501479/XAB) **Consolidated list of chemicals subject to reporting under the Emergency Planning and Community Right-To-Know Act: SARA (Superfund Amendments and Reauthorization Act of 1986) Section 302 Extremely Hazardous Substances, CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act) Hazardous Substances and SARA Section 313 Toxic Chemicals (Title III. List of Lists) (for microcomputers). Data file.** Sykes, H. Environmental Protection Agency, Washington, DC (USA). Office of Toxic Substances. Jan 1990. vp. Available from NTISCP D02.

Supersedes PB–89-158653. See also PB–90-501487. The data file is contained on 5 1/4-inch diskettes, double density (360K), compatible with the IBM PC microcomputer. The diskettes are in the DBASE III Plus format.

The data file is the disk-based version of the Office of Toxic Substances' consolidated list of chemicals subject to reporting under Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA) and SARA Section 302 Extremely Hazardous Substances, as well as CERCLA Hazardous Substances. Title III is also known as the Emergency Planning and Community Right to Know Act. The disks are designed to generate either a printout or a dBase III file from any IBM or IBM compatible system.

32450 **Air toxics compliance issues and case histories from the Kentucky experience.** Browne, C.L. (Camp Dresser and McKee, Inc., Louisville, KY (US)); DeBusschere, M.T.; Mann, J.M. 745-750 of Proceedings of the 43rd industrial waste conference. Lewis Publishers, Chelsea, MI (USA) (1989). (CONF-8805322–: 43. industrial waste conference, West Lafayette, IN (USA), 10-12 May 1988).

Two regulations were passed due to pressure from the Environmental Protection Agency (EPA), and because of legislators' concerns over the health impacts of air-borne contaminants. The regulations were written to limit emissions of toxic compounds based upon threshold limit values published by the National Institute of Occupational Safety and Health (NIOSH). This saved a great deal of time in implementing the regulations, because toxicity and exposure tests were not required. The regulation covering existing facilities included 92 commonly used compounds, and the regulation covering new or modified facilities set limits on nearly 800 compounds. Any facility constructed or modified after November 11, 1986 is required to comply with the new or modified source regulation. Specific industries are exempt under both regulations. These include laboratory facilities, dry cleaners, gasoline dispensing facilities, agricultural operations, indirect heat exchanger operations, and facilities regulated by the National Emission Standards for Hazardous Air Pollutants (NESHAPs). Facilities of note required to comply with the regulations are wastewater treatment plants (municipal and industrial), chemical distributors, bulk gasoline distributors, printing companies, and all major and minor industrial facilities. This chapter presents the approach to determining facility compliance and the difficulties encountered while helping facilities comply with the requirements of the regulations. In addition, case histories of four facilities are presented. The four facilities reviewed will be a light industrial manufacturing plant, a printing company, a paint and coatings manufacturer, and a wastewater treatment plant.

2904 Energy Resources

Refer also to citation(s) 32268

32451 (CMI-R–89/30701) **Sustainable development.** Moxnes, E. Christian Michelsens Inst. for Vitenskap og Aandsfrihet, Bergen (Norway). Oct 1989. 45p. Order Number DE90791370. Available from NTIS (US Sales Only), PC A03/MF A01.

Sustainable development is seen in light of welfare theory and changing resource conditions. A growth model is used to study policies to avoid overshooting. Discount rates should be reduced to promote sustainable development. 63 refs., 15 figs., 2 tabs.

32452 (HNEI–90010836) **Hawaii Natural Energy Institute: 1989 Annual report.** Hawaii Natural Energy Inst., Honolulu, HI (USA). [1990]. 38p. Sponsored by Hawaii Natural Energy Institute. Available from OSTI; Hawaii Natural Energy Institute, University of Hawaii, 2540 Dole Street, Holmes Hall 246, Honolulu, HI 96822.

This document is the 1989 annual report of Hawaii Natural Energy Institute. The institute was established in 1974 by the Hawaii State Legislative to reduce Hawaii's dependence on imported fuels. Progress has been made and the commercialization of some of the programs is near. The programs reported upon are geothermal, hydrogen, biomass, transportation, wind, ocean, ocean resources, materials and applied science. 67 refs., 36 figs. (FSD)

32453 (LA–11765-MS) **Economics of nonrenewable energy resources.** Canavan, G.H. Los Alamos National Lab., NM (USA). May 1990. 16p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. Order Number DE90010261. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Optimal pricing of nonrenewable resources could generate significant rents and value transfers even in an orderly transition from nonrenewable to renewable back-up energy supplies. If the latter were delayed, penalties could be much larger. Interruptions of imports could increase penalties significantly. For short or modest interruptions, strategic reserves are the logical insurance; for longer interruptions, the economy could be forced to adjust and penalties increased. There is little slack in the timetable for transition to renewable sources, so any added constraints generate disproportionate penalties. 5 refs., 6 figs.

32454 (NVE-V-PUB–21) **A case study on optimal water management of small catchments: Aaros river in Norway.** Jakobsen, B.; Herfjord, T. Norges Vassdrags- og Energiverk, Oslo (Norway). Jun 1989. 29p. Order Number DE90791371. Available from NTIS (US Sales Only), PC A03/MF A01.

The Norwegian Water resources and Energy Administration (NVE) is the national authority responsible for the main elements of water resources management. The present case study is mainly based on the "Water Master Plan, Aaros River" in Norway with a catchment area of 115 square kilometres which is in course of preparation. In terms of range, and taking into account practical experience, rivers with catchment areas between a hundred and a few thousand square kilometres are considered as small rivers. The study is one out of more similar studies to be prepared for the "Economic Commission for Europe, Environment and Human Settlements Division" on the same subject. Accordingly, the content of the present study strictly follows the "outline for the preparation" which is submitted from the Divison and contains the following main items: Natural conditions, Socio-economic conditions, Water management and river-basin development, Relation between catchments and neighbouring basins and environments, Interaction between management and socio-economic activities, International cooperation. In addition to the outline, one chapter dealing with the Norwegian Watercource Archives is added. 5 figs., 15 tabs.

32455 (PB–90-174079/XAB) **Renewable-resource management in agriculture. World Bank operations evaluation study.** International Bank for Reconstruction and Development, Washington, DC (USA). c 1989. 204p. Available from NTISMF A02.

Library of Congress catalog card No. 89-48046. Microfiche copies only. Paper copy available from World Bank, 1818 H St., NW, Washington, DC 20433.

The study is the first of a series planned by OED of the Bank's experience in the area of renewable resource management. It analyzes the results of 335 agriculture and forestry projects in the tropics which have been completed. Further, it examines the findings in the case studies of 12 countries. The countries represent the three principal tropical ecologic zones: the humid tropical lowlands; desert and semi-arid lands; and mountain watersheds. They also represent all four of the Bank's operational regions: Africa, Asia, Latin America and the Caribbean, and Europe, Middle East and North Africa. The report reviews the findings of PPARs, PCRs and IERs on resource management issues; summarizes the main findings of the 12 case studies of countries; examines the Bank's role in identifying and dealing with policy issues affecting resource management; and discusses the opportunities and constraints that exist if the Bank is to address resource management problems more effectively.

32456 (PB–90-181462/XAB) **Minerals yearbook, 1988. Tungsten.** Smith, G.R. Bureau of Mines, Washington, DC (USA). 1988. 22p. Available from NTIS, PC A03/MF A01.

Also available from Supt. of Docs.

Only one U.S. tungsten mine was open during 1988 while prices for concentrates rose only modestly from the previous year. Consequently, the United States continued to be highly import-dependent for tungsten concentrate and intermediate materials. A significant portion of these materials came from China. The report discusses the following topics: Domestic data coverage; Legislation and government programs; Domestic production; Consumption and uses; Prices; Foreign trade; World capacity; World review–Australia, Austria, India, Republic of Korea, Mongolia, Rwanda, Spain; Technology.

32457 (PB–90-183179/XAB) **Conservation Reserve Program: An economic assessment. Agricultural economic report.** Young, C.E.; Osborn, C.T. Economic Research Service, Washington, DC (USA). Jan 1990. 37p. (USDA/AER–626). Available from NTIS, PC A03/MF A01.

The Conservation Reserve Program (CRP) will boost net farm income and improve environmental quality substantially over the life of the program (1986-99). These gains will come at the cost of somewhat higher food prices and Government administrative expenses, and potential downturns in farm input industries and other local economic activity tied to farming where enrollment is heavy. Net economic benefits of the program range between $3.4 billion and $11.0 billion in present value, according to estimates derived in the report. The report also looks behind the bottom-line estimate to determine how well the CRP does in reaching each of its multiple goals, which are to reduce soil erosion, protect the Nation's long-term capability to produce food and fiber, reduce sedimentation, improve water quality, create better habitat for fish and wildlife, curb production of surplus commodities, and provide income support to farmers.

32458 (PB–90-184482/XAB) **Minerals yearbook, 1988. Molybdenum.** Blossom, J.W. Bureau of Mines, Washington, DC (USA). 1988. 14p. Available from NTIS, PC A03/MF A01.

Also available from Supt. of Docs.

Domestic and foreign molybdenum markets expanded in 1988 and demand among market economy countries exceeded mine production. Domestic producer and consumer stocks decreased. U.S. mine output of molybdenum increased and represented 45% of the world production. Reported end-use consumption of molybdenum in raw materials and apparent domestic demand both increased. Exports of all forms of molybdenum from the United States increased. Domestic producer stocks of molybdenum products decreased to about 8 months of annual consumption. Topics discussed in the report include domestic data coverage, domestic production, consumption and uses, stocks, prices, foreign trade, world capacity, and world review.

32459 (PB–90-187394/XAB) **Minerals yearbook, 1988. Vanadium.** Hilliard, H.E. Bureau of Mines, Washington, DC (USA). 1988. 14p. Available from NTIS, PC A03/MF A01.

Also available from Supt. of Docs.

Riding on a weaker U.S. dollar and strong international demand, vanadium exports increased to more than $19 million, a level heretofore unattained by the industry. Meanwhile, vanadium imports weighed in at about $15 million, only about $45,000 higher than in 1987. With this surprisingly small increase, the U.S. vanadium industry ended the year with a trade surplus of about $5 million. All in all, then, the vanadium industry ended 1988 riding on strong momentum. Topics discussed in the report include domestic data coverage, legislation and government programs, domestic production, consumption, uses, and stocks, prices, foreign trade,

world capacity, world review–Australia, Brazil, Canada, China, South Africa–and technology.

32460 (PB–90-187469/XAB) **Estimating pumping time and ground-water withdrawals using energy-consumption data. Water-Resources Investigation.** Hurr, R.T.; Litke, D.W. Geological Survey, Denver, CO (USA). Water Resources Div. 1989. 34p. (USGS-BULL–89-4107). Available from NTIS, PC A03/MF A01.

Also available from Supt. of Docs.

Evaluation of the hydrology of an aquifer requires knowledge about the volume of ground water in storage and also about the volume of ground-water withdrawals. Totalizer flow meters may be installed at pumping plants to measure withdrawals; however, it generally is impractical to equip all wells in an area with meters. A viable alternative is the use of rate-time methods to estimate withdrawals. The relation between power demand and pumping rate at a pumping plant can be described through the use of the power-consumption coefficient. Where equipment and hydrologic conditions are stable, this coefficient can be applied to total energy consumption at a site to estimate total ground-water withdrawals. Random sampling of power-consumption coefficients can be used to estimate area-wide ground-water withdrawals.

32461 (PB–90-188038/XAB) **Minerals yearbook, 1988. Rare-earth minerals and metals.** Hedrick, J.B.; Templeton, D.A. Bureau of Mines, Washington, DC (USA). 1988. 16p. Available from NTIS, PC A03/MF A01.

Also available from Supt. of Docs.

Domestic production of rare-earth concentrates decreased in 1988. Foreign sources of processed rare earths obtained a slightly larger share of the U.S. market, while domestic exports saw a marked increase compared to 1987 levels. Rare earths were used in high-technology applications such as laser crystals, high-strength permanent magnets, optical fibers, magnetic resonance imaging (MRI) scanners, and high-temperature superconductors. Topics discussed in the report include domestic data coverage, legislation and government programs, environmental issues, domestic production, consumption and uses, stocks, prices, foreign trade, world capacity, world review–Australia, Brazil, Canada, China, Egypt, Greenland, Japan, Madagascar, Malaysia, Mozambique, Sri Lanka, Thailand–and technology.

2905 Research, Development, Demonstration, and Commercialization

Refer also to citation(s) 32219, 32220, 32349, 32452, 32472, 32529, 32941, 33000, 33630, 33655, 33656

32462 (BNL–44454) **Nuclear engineering research opportunities at Brookhaven National Laboratories.** Metz, D.J. Brookhaven National Lab., Upton, NY (USA). [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-9006175–1: Meeting of the American Society for Engineering Education, Toronto (Canada), Jun 1990). Order Number DE90010642. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Brookhaven National Laboratory (BNL) is a Department of Energy (DOE) multiprogram Laboratory, and is operated under contract with DOE by Associated Universities, Inc. (AUI). BNL conducts a wide range of basic and applied research and development in the physical and life sciences and designs, builds, operates and maintains a large array of very large research devices such as particle accelerators, nuclear reactors, and a synchrotron light source.These devices are used not only by the resident staff for its own research interests, but, more importantly, are made available to qualified users from the scientific and technical communities to an extent that far exceeds the in-house use. Thus, these specialized facilities are designated user facilities. In a similar manner, many smaller and less visible devices and laboratories are available to a large number of outside collaborators, including students, faculty, and practicing scientists and engineers. Brief descriptions of a variety of research and development areas involving nuclear engineering expertise are presented . Also, various ways for students, faculty and practicing engineers to gain access to and become part of these activities are described.

32463 (DOE/ER–0428) **Technology '89: R and D Laboratory technology transfer program: Accomplishments in technology transfer from DOE [Department of Energy] and it laboratories.** USDOE, Washington, DC (USA). Jan 1990. 213p. Sponsored by U.S. DOE Energy Research. Order Number DE90002686. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

Technology transfer from DOE laboratories to industry is increasing. Technology transfer opportunities have many forms, including new materials, new and enhanced technologies, improved processes, technical know-how, unique experimental facilities, and computer software. The applied research programs — Nuclear Energy, Conservation and Renewable Energy, and Fossil Energy — include technology transfer activities that are referred to as program directed. When the technology is used for secondary applications or an application that differs from the original purpose for which the technology was developed, spin-off transfer occurs. The laboratories are the predominant implementors of spin-off transfer activities. Private-sector companies, universities, and consortia are also integral participants for program implementation. In this document, the technology transfer accomplishments of DOE's research programs and some of the best from its R&D laboratories are described and illustrated. This document is intended to communicate a few of the many opportunities available for US industry and universities to work with DOE and its laboratories.

32464 (GAO/RCED–89-118) **Energy management: DOE has not shown systems contracting to be in government's best interest.** General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div. Aug 1989. 23p. Available from US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877 (USA).

Systems contracting is a method of procuring a family of items - such as office, industrial, and laboratory supplies - from a vendor, who agrees to maintain an inventory of specified items and deliver them at a specified price as they are needed by the contractors operating Department of Energy nuclear research and production facilities. This paper presents a GAO report on the DOE. Although DOE has cited the experience of Sandia National Laboratories, which awarded the first systems contract in 1985, as a basis for encouraging other operating contractors to use systems contracting, DOE has not independently reviewed the costs and benefits of systems contracting or evaluated Sandia's studies. Further, DOE has not required Sandia to establish adequate internal controls over purchases under its office supplies systems contract.

32465 (PB–90-188087/XAB) **Emerging technologies in electronics and their measurement needs. Second edition.** National Inst. of Standards and Technology (NEL), Gaithersburg, MD (USA). Center for Electronics and Electrical Engineering. Feb 1990. 195p. (NISTIR–90/4260). Available from NTIS, PC A09/MF A02.

Also available from Supt. of Docs. See also PB–89-189245.

The National Institute of Standards and Technology (NIST) is the nation's lead organization for the development of measurement capability and for the maintenance of national reference standards that assure the uniformity of that capability. Within NIST, the Center for Electronics and Electrical Engineering (CEEE) is responsible for measurements that support the U.S. electronics industry. As part of fulfilling this responsibility, CEEE assesses measurement needs that affect the competitiveness of the U.S. electronics industry in emerging technologies. The report is the second in a series that seeks to provide an increasingly comprehensive assessment of those needs.

32466 (PB–90-188095/XAB) **Center for Electronics and Electrical Engineering Technical Progress Bulletin covering Center programs, July to September 1989, with 1990 CEEE events calendar.** Walters, E.J. National Inst. of Standards and Technology (NEL), Gaithersburg, MD (USA). Center for Electronics and Electrical Engineering. Feb 1990. 42p. (NISTIR–90/4236). Available from NTIS, PC A03/MF A01.

See also PB–90-132721.

The issue contains abstracts for all Center papers released for publication by the National Institute of Standards and Technology in the quarter and citations and abstracts for Center papers published in the quarter. Technical topics addressed include: Semiconductor

technology; Fast signal acquisition, processing, and transmission; Electrical systems; and Radiated electromagnetic interference.

32467 (PNL-SA–17482) **The technology transfer process: Background for the US national energy strategy.** Deonigi, D.E. (Pacific Northwest Lab., Richland, WA (USA)); Moore, N.L.; Smith, S.A.; Watts, R.L.; Brown, M.A.; Noun, R.J. Pacific Northwest Lab., Richland, WA (USA). Jan 1990. 55p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC06-76RL01830. Order Number DE90010256. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This paper describes the objectives, strategies, and mechanisms used by the US Department of Energy (DOE), its laboratories, other government and private technology development organizations in their technology transfer programs. Its scope is limited to listing the technology transfer mechanisms and defining the situations when these particular mechanisms are most effective. In this paper, the specific mechanisms for transferring technology, ant the advantages and disadvantages of each are listed based on federal laboratories' and industry's experiences in using these mechanisms. In addition, several case studies illustrating how technology transfer strategies using multiple mechanisms have been executed successfully. The conclusions of this paper support those reported by the Energy Research Advisory Board (ERAB) in 1988. 8 refs., 2 figs., 1 tab.

2906 Nuclear Energy

Refer also to citation(s) 32218, 32251, 32259, 32328, 32329

2907 Transport and Storage

Refer also to citation(s) 32490

2910 Conservation

Refer also to citation(s) 32479, 32494, 32495

2920 Supply, Demand, and Forecasting

Refer also to citation(s) 32430, 32460

2930 Policy, Legislation, and Regulation

Refer also to citation(s) 32493, 33141, 33836, 33837

32468 (GAO/NSLAD–90-19) **CBM modernization: Rail garrison production decision and launch car acquisition should be delayed.** General Accounting Office, Washington, DC (USA). National Security and International Affairs Div. Dec 1989. 6p. Available from US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877 (USA).

As part of its periodic reviews of the Air Force's intercontinental ballistic missile modernization effort, GAO evaluated the current and planned land-based ICBM force structure. During GAO's review, the Secretary of Defense announced that the 50 Peacekeeper missile force will be moved from the silos at F.E. Warren Air Force Base, Wyoming, to rail garrisons at various Air Force installations. This report discusses how the announcement provides an opportunity for the Air Force to revise its missile launch car acquisition schedule and to consider more fully operational test and evaluation results before deciding to begin initial and full production of the system.

32469 (GAO/NSLAD–90-26) **Reserve force: DOD guidance needed on assigning roles to reserve under the total policy.** General Accounting Office, Washington, DC (USA). National Security and International Affairs Div. Dec 1989. 65p. Available from US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877 (USA).

The reserves of the U.S. military services are expected to play a major role in any large-scale conflicts or wars. In a November 1988 report, GAO pointed out the need for DOD policy guidance in force mix decision-making. This paper presents a GAO report that restates the need for additional guidance on the basic parameters for force mix decisions. Although all the services cite force mix decision criteria, GAO could not determine the relative influence of the various factors on force mix decisions or the thoroughness of the decision process. This is because decisions on reserve components usually are by-products of overall force structure decision-making under planning, programming, and budgeting processes in each service. There is little documentation of decision-making regarding reserve components within those processes. During these decision processes, marginal changes are often made regarding the use of reserve components. Over time, these changes have resulted in significant reliance on reserve components.

2940 Fossil Fuels

Refer also to citation(s) 32046, 32079, 32113, 32121, 32147, 32148, 32174, 32175, 32177

2950 Hydrogen and Synthetic Fuels

Refer also to citation(s) 32525, 32526

2960 Electric Power

Refer also to citation(s) 32174, 32175, 32317, 32436, 32479

32470 (ANL/EAIS/TM–10) **Introduction to the Argonne Utility Simulation (ARGUS) model.** Veselka, T.D. (Argonne National Lab., IL (USA). Environmental Assessment and Information Sciences Div.); VanKuiken, J.C.; Parker, G.D.; Rose, K. Argonne National Lab., IL (USA). Environmental Assessment and Information Sciences Div. Mar 1990. 95p. Sponsored by U.S. DOE Fossil Energy; U.S. DOE Office of Policy, Planning and Analysis. DOE Contract W-31109-ENG-38. Order Number DE90010304. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The Argonne Utility Simulation (ARGUS) model accounts for the interplay of economic, environmental, and technological factors in energy policy issues and emission-control strategies. Each of the four components of ARGUS represents a specific aspect of the utility sector. One component deals with meeting future electricity demand through construction of new units or refurbishment or repowering of existing units. A second component is concerned with the probability of generating-unit failure and the effect that such failure could have on generating-unit assignment, fuel use, and costs. A third component computes the cost of implementing emission-control regulations and strategies. The fourth component forecasts delivered coal prices based on the volume of coal, supply region, and transportation route. Each component of ARGUS includes features that are advances over similar national-scale models, thus enabling a more efficient and accurate simulation of the utility sector. 36 refs., 19 figs., 4 tabs.

2980 Consumption and Utilization

32471 (FRCEA-R–51) **Energy in China.** Kracht, G.; Schroeder, M.H. CEA, 75 - Paris (France). Dept. des Programmes. Nov 1989. 69p. (In French). Order Number DE90790634. Available from NTIS (US Sales Only), PC A04/MF A01.

A global survey of the energy potentials, demand and supply in China is presented. The various energy sources are evaluated (coal, oil, gas, asphaltic sands, uranium); the production, consumption and energy demand statistics are presented and the energy policy is discussed. Electric power production is then examined is details: thermal and hydroelectric power, nuclear electric power. Models for energy demand in China are also presented.

2990 Unconventional Sources and Power Generation

Refer also to citation(s) 32263, 32524

32472 (PAI–CE02994) **Renewable energy research and development workshop.** Passmore Associates International, Ottawa, ON (Canada). Oct 1985. 75p. (CE–02994). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St.,

Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

In October 1985, 26 questions were put to 70 specialists for the private sector, universities and other institutions, and government and other public bodies on the subject of 5 renewable energy sources: wind power, passive solar power, small hydroelectric power, active solar power, and photovoltaic power and also on the subject of multidisciplinary research in support of these energy sources. The results of this panel discussion are summarized in the present report. The lessons learnt, the suggestions for improvements, criticisms of the management process, and technological goals are listed; suggestions are made to improve the dissemination of information. The general conclusions of the discussion are that: there is a need for the Department of Energy, Mines and Resources (EMR) to establish specific goals for each technology; administrative procedures should be simplified; there is a need for continuity and long-term contracts and a need to support Canadian content in the research and development; there should be no limit to government funding; the role of the technology-specific advisory committees should be expanded; at least 1 contact person at EMR should specialize in each technology area; for most renewable energy technologies, the commercialization time of new products is 3 to 5 years; and information dissemination should be improved. It was recommended that even with government funding, the intellectual property of the results should reside with the private sector. The names and addresses of all the participants in the panel discussion are given at the end of the report.

30 DIRECT ENERGY CONVERSION

3001 MHD Generators

32473 (CONF-9006105–1) **Comparative three-dimensional flow analysis of MHD generators and seawater thrusters.** Doss, E.D. (Argonne National Lab., IL (USA)); Roy, G.D. Argonne National Lab., IL (USA). [1990]. 9p. Sponsored by U.S. Department of Defense. DOE Contract W-31109-ENG-38. Contract N00014-89-F-0064. From 28. symposium on engineering aspects of magnetohydrodynamics; Chicago, IL (USA); 26-28 Jun 1990. Order Number DE90011160. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The three-dimensional flow characteristics inside MHD plasma generators and seawater thrusters are analyzed by solving the governing partial differential equations for flow and electrical fields. The equation set consists of the mass continuity equation, the three momentum equations, the equations for enthalpy, turbulence kinetic energy and its dissipation rate, and the Maxwell equations. Calculations have been performed for a Faraday plasma generator and for a continuous electrode seawater thruster. The numerical results of those two applications are compared. Calculations have been made to study the flow evolution in MHD generators and thrusters. The calculations show that velocity overshoots friction enhancement exist over the sidewalls and are strongly manifested in MHD generators but not so in MHD thrusters. Plots of velocity and skin friction are presented to illustrate the flow development in MHD generators and thrusters. 17 refs., 8 figs., 1 tab.

32474 (DOE/ID/12735–T8) **Component Development and Integration Facility quarterly technical progress report, January 1–March 31, 1990.** MSE, Inc., Butte, MT (USA). [1990]. 10p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC07-88ID12735. Order Number DE90011140. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This quarterly technical progress report presents the tasks accomplished at the Component Development and Integration Facility during the second quarter of FY90. Areas of technical progress this quarter included: coal system development; seed system development; test bay modification; channel power dissipation and distribution system development; integrated topping cycle/proof-of-concept current controls project; split coal feed system; oxygen system storage upgrade; iron core magnet thermal protection system checkout; TRW slag rejector/CDIF slag removal project; stack gas/environmental compliance upgrade; coal-fired combustor support; 1A channels fabrication and assembly; support of Mississippi State University diagnostic testing; test operations and results; data enhancement; data analysis and modeling; technical papers; and projected activities. 2 tabs.

32475 (PIRSEM–3008) **Tin-water magnetohydrodynamic electric power generator.** Alemany, A. Centre National de la Recherche Scientifique, 75 - Paris (France). Programme Interdisciplinaire de Recherche sur les Sciences pour l'Energie et les Matiernes Premieres (PRISEM); Grenoble-1 Univ., 38 (France). Nov 1986. 35p. (In French). Order Number DE90790629. Available from NTIS (US Sales Only), PC A03/MF A01.

Modelization and experiments haw been conducted to study a liquid-metal Faraday nozzle with liquid tin and water vapour. Two experimental models for the simulation of the operation of a dual-elements Faraday generator, adapted to the electric power production in space, have been realized and tested: separation of the two phases of a high speed flowing fog, and experimental analysis of the induction machine operation.

3005 Fuel Cells

Refer also to citation(s) 32264

32476 (DOE/MC/25009–2838) **Effects of coal-derived trace species on the performance of molten carbonate fuel cells: Technical progress report No. 15 (annual progress and interim project evaluation), August 22, 1988–August 21, 1990.** Pigeaud, A. Energy Research Corp., Danbury, CT (USA). Dec 1989. 23p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-88MC25009. Order Number DE90011186. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The primary objective of this study is to assess the overall and combined effect of coal-derived gas-phase trace contaminants. The species will be simultaneously present in fuel gas at concentrations near the single contaminant tolerance levels found for the MCFC. The species will include, but are not limited to mercury (Hg), tin (Sn), lead (Pb), selenium (Se), arsenic (As), and zinc (Zn) in the presence of ammonia (NH_3), hydrogen sulfide (H_2S) and halide (HCl). Results to-date are discussed. 49 refs., 1 fig., 4 tabs.

32477 (PB–90-183237/XAB) **Monolithic solid oxide fuel-cell technology development. Phase 1A. Final report, February 1987-March 1989.** Minh, N.Q.; McPheeters, C.E.; Brule, J.E. Allied-Signal Aerospace Co., Torrance, CA (USA). AiResearch Los Angeles Div. Jun 1989. 71p. (REPT–89-62529). Available from NTIS, PC A04/MF A01.

This work was directed toward development of a scaleable fabrication methodology to produce the monolithic solid oxide fuel cell (MSOFC) and demonstration of the electrochemical performance of fabricated cells and stacks. In the fabrication effort, MSOFC cells and stacks were successfully fabricated. Material characteristics, batch formulations, and forming and processing parameters were tailored and controlled to produce the MSOFC with the desired properties, especially a close match in firing characteristics of the individual components. MSOFC stacks in sizes up to 2 x 2 x 2 1/2 in. were formed and fired to demonstrate fabrication scaleability. In the testing effort, fabricated single cells exceeded initial performance and life goals, and cell performance was significantly improved, approaching the maximum performance limited by material resistance. One-cell to three-cell stacks of up to 3-in.-square footprints were built and operated with hydrogen fuel and air oxidant.

32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

3201 Buildings

Refer also to citation(s) 32176, 32291, 32499, 32507, 32701, 33049, 33118

32478 (BR–129) **Daylighting as a passive solar energy option: an assessment of its potential in non-domestic buildings.** Crisp, V.H.C.; Littlefair, P.J.; Cooper, I.; McKennan, G. Building Research Establishment, Watford (UK). 1988. 62p. Available from Building Research Est. Bucknalls Lane, Garston, Watford, WD2 7JR, UK. Price Pound 15.00.

This BRE Report examines the opportunities for exploiting daylight in non-domestic buildings and it assesses the factors which need to be considered if such exploitation is to be successful. The report contains an appraisal of (1) the potential contribution of daylighting design to energy efficiency, (2) the opportunities for and constraints upon the exploitation of daylight in building design and (3) the visual aspects of daylighting in passive solar buildings. Finally recommendations for further work are suggested. (UK).

32479 (CONF-870811–Vol.2) **Energy conservation program evaluation: Practical methods, useful results: Proceedings: Volume 2, August 20 and 21 sessions.** Argonne National Lab., IL (USA); USDOE Bonneville Power Administration, Portland, OR (USA); Illinois Dept. of Energy and Natural Resources, Chicago, IL (USA); USDOE, Washington, DC (USA). [1987]. 502p. Sponsored by U.S. DOE Bonneville Power Administration; U.S. DOE Energy Research; Illinois Department of Energy and Natural Resources. DOE Contract W-31109-ENG-38. From Energy conservation program evaluation: practical methods and useful results; Chicago, IL (USA); 19-21 Aug 1987. Order Number DE90010891. Available from NTIS, PC A21/MF A01 - OSTI; GPO Dep.

The success of cutting-edge evaluation methodologies depends on our ability to merge, manage, and maintain huge amounts of data. Equally important is presenting results of the subsequent analysis in a meaningful way. These topics are addressed at this session. The considerable amounts of data that have been collected about energy conservation programs are rarely used by other researchers, either because they are not available in computerized form or, if they are, because of the difficulties of interpreting someone else's data, format inconsistencies, incompatibility of computers, lack of documentation, data entry errors, and obtaining data use agreements. Even census, RECS, and AHS data can be best used only by a researcher who is intimately familiar with them. Once the data have been accessed and analyzed, the results need to be put in a format that can be readily understood by others. This is a particularly difficult task when submetered data is the basis of the analysis. Stoops and Gilbride will demonstrate their methods of using off-the-shelf graphics software to illustrate complex hourly data from nonresidential buildings.

32480 (CONF-900724–4) **Performance experience with radon mitigation systems.** Gammage, R.B.; Wilson, D.L. Oak Ridge National Lab., TN (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 5. international conference on indoor air quality and climate; Toronto (Canada); 29 Jul - 3 aug 1990. Order Number DE90009236. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Both passive and active radon mitigations were installed in four houses with slab-on-grade or combined crawlspace/slab-on-grade basements. Passive mitigation reduced indoor radon by 40 to 80%. Combined passive and active mitigation was necessary for reducing radon levels to below 150 Bq m^{-3}. Active mitigation employed sub vapor-barrier and/or subslab depressurization. The number of subslab mitigation pits needed at each house was determined by diagnostic measurements of permeability and pressure-field extension. Performances of the mitigation systems at three houses were stable over one year. Increasing permeability in the hard-packed clay beneath the slab of one house may result in decreased effectiveness of the subslab depressurization. 2 refs., 2 figs., 1 tab.

32481 (CONF-900724–5) **First-phase study design for the US Navy Radon Assessment and Mitigation Program (NAVRAMP).** Wilson, D.L.; Gammage, R.B.; Matthews, T.G. Oak Ridge National Lab., TN (USA). [1990]. 8p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 5. international conference on indoor air quality and climate; Toronto (Canada); 29 Jul - 3 aug 1990. Order Number DE90009421. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In 1988, the US Navy initiated a worldwide multi-year program for the assessment and mitigation of radon inside buildings under its control. During the first two years of the program, radon levels in residences occupied by Navy personnel and their dependents are being surveyed. Also being surveyed are all schools, child care centers, hospitals, and brigs in addition to a small random sample of bachelor quarters. Passive alpha-track detectors, numbering about 25,000, are being used as monitoring devices. A substantial fraction of the monitors (20%) are being used for quality assurance. Data management programs have been developed to record the chain of custody of the monitors and handle the associated questionnaire data. Program objectives and implementation emphasize quality assurance, records maintenance, and monitor placement and retrieval. 5 refs., 2 tabs.

32482 (DOE/BP/13795–23) **Case study of the regional manufacturers' participation in the manufactured housing RCDP [Residential Construction Demonstration Project].** Lee, A.D.; Harkreader, S.A. USDOE Bonneville Power Administration, Portland, OR (USA). Dec 1989. 33p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. (PNL–7176). Order Number DE90010258. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The goal of the Residential Construction Demonstration Project (RCDP) is "to develop reliable alternatives for building energy-efficient homes by (1) developing ··· conservation techniques and innovations; (2) examining (these) conservation techniques and innovations; ··· [and] (3) introducing the use of innovations which show potential to be reliable, cost effective, and marketable" (WSEO 1987a). Manufactured housing was included in RCDP Cycle 2. Through manufacturer, dealer, and occupant incentives, the RCDP for manufactured housing encouraged participant manufactures to build homes meeting strict energy-efficiency requirements; 150 manufatured homes were built under the project. As specified under the project, these homes were built to Bonneville's Super GOOD CENTS (SGC) specifications to meet Model Conservation Standards (MCS) requirements. Three objectives for evaluating the Manufactured Housing innovation in RCDP are: provide a basis for characterizing and assessing the experiences of participating manufacturers; provide a basis for identifying the characteristics of the manufacturers and the program that affected the success of the manufactured housing RCDP; and identify potential technology transfer mechanisms. This report presents the findings in each of these areas. 5 refs.

32483 **Passive cooling.** Solar heat technologies: Fundamentals and applications. Cook, J. (ed.). 593p. Massachusetts Institute of Technology, Cambridge, MA (1989). Sponsored by U.S. DOE Conservation & Renewable Energy.

The series of twelve volumes summarizes research, development, and implementation of solar thermal energy conversion technologies carried out under federal sponsorship during the last eleven years of the National Solar Energy Program. The purpose of the project has been to conduct a thorough, objective technical assessment of the findings of the federal program using leading experts from both the public and private sectors, and to document the most significant advances and findings. The present volume covers research into methods of maintaining comfort in buildings in hot or warm climates by means other than mechanical refrigeration. This subject was originally included as a section of the volume on passive solar buildings, but it was promoted to a separate volume when the extent of the material available and the level of interest in the research and architectural communities became evident. Each section of this volume will be catalogue individually.

32484 (EPRI-CU–6817) **Dust and ventilation effects on radiant barriers: Cooling season energy measurements: Final report.** Levins, W.P. (Oak Ridge National Lab., TN (USA)); Karnitz, M.A.; Hall, J.A. Electric Power Research Inst., Palo Alto, CA (USA); Oak Ridge National Lab., TN (USA). c May 1990. 72p. Sponsored by U.S. DOE Conservation & Renewable Energy; Electric Power Research Institute; Tennessee Valley Authority. DOE Contract AC05-84OR21400. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Cooling season tests were conducted in three unoccupied ranch-style houses in Karns, Tennessee, to determine the effects on attic

radiant barrier performance incurred by changes in attic ventilation area ratio, attic ventilation type, and the buildup of dust on horizontal radiant barriers. All three houses had R-19 fiberglass batt insulation in their attics. Horizontal radiant barriers were artificially dusted and the dusted barriers showed measurable performance degradations, although the dusted barriers were still superior to no radiant barriers. Dust loadings of 0.34 and 0.74 mg/cm^2 reduced a clean radiant barrier surface emissivity of 0.055 to 0.125 and 0.185, respectively. Total house cooling load increases amounted to 2.3 and 8.4% compared to house loads with clean horizontal barriers, respectively. When compared to R-19 with no horizontal radiant barrier conditions, the dusted horizontal radiant barriers reduced cooling loads by about 7%. Testing showed that increasing the attic ventilation area ratio from the minimum recommended of 1/300 to 1/150 had little if any effect on the house cooling load with either truss or horizontal barriers present in the attics. Radiant barriers, however, still reduced the house cooling load. There was essentially no difference in house cooling load reduction between either ridge/soffit or gable/soffit vent type with a truss radiant barrier, as both reduced cooling loads by about 8% when compared to no radiant barrier conditions. The attic-ventilation-type testing was done with a ventilation area ratio of 1/150.

32485 (MA–34SZ.01843-0-CP01) **Energy requirements in Canadian restaurants: Final report.** Leitch, P.; Lanczi, T.; Love, P. Middleton Associates, Toronto, ON (Canada). 17 Aug 1981. vp. (CE–02930). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This study examines the energy demand of restaurants in Canada. Energy use data were collected from 100 restaurants in a mail survey, and from 44 restaurants during on-site energy audits. Four restaurants were monitored over a 14 day period. For the purpose of the analysis the restaurants were divided into according to the type of service they provided. For each category average values are calculated for: total annual energy consumption, total annual energy expenses, expenses per unit of delivered energy, energy consumption per customer, and the fraction of the total cash flow being spent on energy expenses. Energy consumption by function for the following 5 functions was estimated: cooking and serving; refrigeration; washing; heating, ventilating and air conditioning (HVAC); and lighting. Estimates were based on nameplate information and the restaurant staff's estimates of operating hours. These estimates indicate that HVAC accounts for 30 to 55% of the total energy consumption, while cooking and serving require 20 to 40% of the total energy consumption. Finally, one restaurant in each category was continuously monitored over a 14 day period. This monitoring indicated that nameplate information is often inaccurate, and restaurant staff is not familiar with the service cycles of appliances. Discrepancies between rated performance (on nameplates) and actual performance point, in part, to inadequate servicing and maintenance programs. Ignorance of service cycles among restaurant staff may account for a part of the inefficiency in energy use. Restaurants with energy conservation programs had a lower energy use than average for their category by as much as 25%. 9 refs., 1 fig., 46 tabs.

32486 (PB–90-186891/XAB) **Lumen Day: A new concept for daylighting design in commercial buildings. Final report on Phase 1.** Robbins, C.L.; Wortman, D.N. Architectural Energy Corp., Boulder, CO (USA). 31 Jul 1987. 350p. Available from NTIS, PC A15/MF A02.

Portions of this document are not fully legible.

The project addressed the benefits of commercial building-design techniques that utilize daylighting as an interior illuminant. Climatological data are used to develop a daylighting/design analysis method leading to climate-responsive, energy-efficient, commercial buildings. The method that was developed is called the Lumen Day Method. The method uses a statistical summary of the daylight resource, in combination with daylight aperture characteristics, and electric lighting-control strategies, to determine the daylighting-system performance efficiency as well as the electric-lighting energy use. The simple method allows for reasonable architecture/engineering design decision making during the early phases of the building-design process, but requires the generation of a burdensome amount of data for each city.

32487 (PB–90-862897/XAB) **Insulating coatings (excluding electrical insulation). January 1980-November 1989 (A Bibliography from World Surface Coatings Abstracts). Report for January 1980-November 1989.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 48p. Available from NTISPC N01/MF N01.

Supersedes PB–86-866688.

This bibliography contains citations concerning compositions and methods of applying coatings that provide insulation. Thermal and acoustic insulation are stressed. Electrically insulating coatings are covered in another bibliography. Paint, films, asbestos, fiber, and plastic coatings are examined. Citations of selected patents are included. Insulation coatings designed for cement, pipes, walls, roofs, building interiors and exteriors, and vehicles are described. (This updated bibliography contains 99 citations, 46 of which are new entries to the previous edition.)

32488 (YEDT–3766-4-3) **Senior citizens retrofits: Final project summary.** Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). Feb 1985. 147p. (CE–02922). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The Seniors' Residential Retrofitting Project was Yukon's most ambitious CREDA, funded demonstration with a total cost of $460,000. The project undertook to demonstrate energy-efficient retrofitting techniques in 38 homes and two apartment complexes for senior citizens. At the same time, the project strove to train Yukon tradesmen in retrofitting techniques, thus creating a local industry and employment within this industry. To this end, two training courses were given for local tradesmen and contractors, the first of their kind in Canada. The training part of the project was given equal importance as the actual demonstration part. Three levels of retrofit work were done on the homes of senior citizens. Level one included caulking, weatherstripping, furnace servicing, and installation of water flow restrictors, water heater blankets and timers. The level two retrofit included the treatment in level one, plus upgrading windows and the insulation levels in walls and ceilings. A level three retrofit involved a total rewrap of the building shell with some of the features in levels one and two incorporated. The demonstration program included the following steps: initial contact with senior citizens; energy audit on each house; determination of level of retrofit work based on individual audit results; contract packages drawn up and put to tender; monitoring of fuel records and air-tightness tests both before and after retrofit; and tabulation of data and information transfer. 10 figs., 4 tabs.

32489 (YEDT–3766-4-9) **Solar swimming pool: Final project summary.** Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). Jan 1985. 29p. (CE–02918). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report examines the feasibility of using solar collectors to heat the water in a previously unheated outdoor swimming pool. The solar system is used in conjunction with a pool blanket, to conserve heat when the pool is not in use. Energy losses through evaporation can be reduced by as much as 70% by a pool blanket. A total of 130 m^2 of highly durable black synthetic collectors were installed on a support structure at a 30° angle from the horizontal, oriented to the south. Circulation of pool water though the collectors, which is controlled by a differential thermostat, was done with the existing pool pump. Before installation the pool temperature averaged 16°C; after installation it ranged from 20° to 26°C. It was hard to distinguish how much pool heating was due to the solar system and how much heat was retained by the pool blanket. However, the pool season was extended by five weeks and attendance tripled. 2 figs.

32490 **Practical ice thermal storage applications.** George, M.L. (Baltimore Aircoil Company (US)). 5p. New York State Energy

Research and Development Authority, Albany, NY (USA) (1987). (CONF-870963–: Electric thermal storage conference and exposition, Binghamton, NY (USA), 22-24 Sep 1987).

The author discusses how ice thermal storage has become the practical response to utility rate structures designed to encourage energy storage and load shifting. Ice thermal energy storage systems have been and are being installed based on savings in operating costs, and resulting in HVAC systems economical for now and in the future. Owners and designers are also taking advantage of the low temperature supply water available with ice storage to provide first cost reductions in pumping, piping, and air-side equipment. These four systems presented in this paper show that the savings due to ice storage both form shifting load and from the benefits of low temperature in reducing piping and ductwork costs make ice thermal storage practical for many different HVAC systems.

3202 Transportation

Refer also to citation(s) 32525, 32709, 32882, 32988, 33056, 33853

32491 (CONF-9004194–1) **Validation of "System 21" monobeam transit with computer analysis and large models: Final draft.** Edwards, L.K. (Futrex, Inc., Fairfax, VA (USA)); Ahlbeck, D.R.; Lissaman, P.B.S.; Mouton, W.J.; Powell, R.O. Edwards (L.K.) DBA Transit, Inc., Falls Church, VA (USA). [1990]. 10p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-89CE15439. From ASME/IEEE joint railroad conference; Chicago, IL (USA); 16-19 Apr 1990. Order Number DE90010046. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Validation of four key features of the new "SYSTEM 21" aerial rapid transit system are discussed: Assessment of tension tie between car and beam by Mr. Ahlbeck; Dynamic analysis of cars/trains traveling along the guideway at speeds to 100 mph, by Dr. Lissaman; Analyses of guideway beam strength and rigidity by Dr. Powell and Prof. Mouton; Quarter-scale models to validate outrigger kinematics and modular makeup of the guideway and station. There are strong indications of suitability for operation at inter-city speeds as well. Most of this was done under a DOE grant to FUTREX in 1989, addressing issues identified by the National Bureau of Standards. 7 refs., 17 figs., 1 tab.

32492 (GAO/PEMD–90-1) **Traffic congestion: Trends, measures, and effects.** General Accounting Office, Washington, DC (USA). Program Evaluation and Methodology Div. Dec 1989. 86p. Available from US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877 (USA).

Many transportation experts believe that escalating traffic congestion threatens the efficient movement of people and commerce in the United States. Moreover, some believe that traffic congestion could become the number one surface transportation problem by the 1990s and into the next century. This report seeks to provide an overview of the traffic congestion problem. GAO examined the following questions: What forces affect the traffic congestion problem and how have they shaped its nature and severity? How is traffic congestion measured and how credible are the estimates of urban freeway delay developed by the Federal Highway Administration? What effects of traffic congestion have been measured?

32493 (GAO/PEMO–90-2) **Traffic congestion: Federal efforts to improve mobility.** General Accounting Office, Washington, DC (USA). Program Evaluation and Methodology Div. Dec 1989. 89p. Available from US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877 (USA).

Both rural and urban interstates are becoming increasingly crowded. Reauthorization of the Highway Trust Fund in the early 1990s will give Congress and DOT an opportunity to consider changes in the federal role toward improving freeway and roadway mobility. This study presents a comprehensive overview of current DOT efforts to reduce traffic congestion. The study addresses three questions: What activities does DOT now have underway to help communities alleviate traffic congestion? What resources does DOT use to support its congestion reduction activities? What evaluation efforts are being made to assess the effectiveness of DOT's congestion reduction activities?

32494 (PB–90-184193/XAB) **Transportation plan for the shuttle bus: Saco-Biddeford-Old Orchard Beach.** TAMS Consultants, Inc., Boston, MA (USA). Nov 1989. 66p. Available from NTIS, PC A04/MF A01.

The purpose of the project was to assess current and future needs of the shuttle bus system and its users. Unlike other fixed-route public transportation systems in Maine, the shuttle bus has not experienced losses in ridership. It is delivering cost-effective services, operating with a minimum number of personnel, and paying-out below market rate wages to full-time drivers. The study consists of 4 parts: Evaluation of current services and operations; Development of a marketing program; Passenger survey and analysis; and a Five-Year Transportation Development Program. The shuttle bus system provides an important service to community residents. It is supported by farebox revenues and municipal funds. Although capital replacement needs are critical, it appears that the shuttle can meet vehicle replacement needs, maintain existing levels of service, and stabilize ridership and revenue with cost increases of about 5-8% annually. The study calls for an expanded effort to increase revenues through more aggressive marketing and increased federal/state fundings.

32495 (PB–90-191560/XAB) **National urban-mass-transportation statistics. 1988 Section 15. Annual report. Report for 1 January-31 December 1988.** Shorter, R.; Ammann, W.C. Compex Corp., Alexandria, VA (USA). Dec 1989. 656p. Available from NTIS, PC A99/MF A04.

Also available from Supt. of Docs. See also report for 1987, PB–90-146432.

The report summarizes the financial and operating data submitted to the Urban Mass Transportation Administration by the nation's public transit operators, pursuant to Section 15 of the Urban Mass Transportation Act of 1964, as amended. The report consists of three chapters. Chapter 1 contains an introduction to the Section 15 reporting system and its relationship to the Section 9 program. Chapter 2 contains aggregate industry statistics derived from the complete Section 15 reports which were submitted. Chapter 3 contains financial and operating data on the individual transit systems that submitted complete Section 15 reports. All data in the report are for transit years ending on or between January 1 and December 31, 1988.

32496 (SAND–88-1958) **Distance and clearance perception using forward-looking, vehicular television systems.** Miller, D.P. Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 15p. Sponsored by U.S. Department of Defense. DOE Contract AC04-76DP00789. Order Number DE90010273. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

During off-road navigation, drivers often must make size, distance, and clearance judgments of terrain features and obstacles in order to choose safe navigational routes. These same judgments must be made in the teleoperation of land vehicles using forward-looking television systems. This study evaluated how well subjects perceived size, distance, and clearance using monochrome and color television systems. Thirty-eight subjects (Ss) estimated the size, distance, and separation of two obstacles using video imagery produced by a forward-looking, vehicle-mounted camera. Results indicate that Ss typically overestimated distances and, when in error judging clearance, tended to overestimate the gap between the objects. These biases were expected, given the well-documented minification effect of television using standard lenses. More surprising was the somewhat larger bias evidenced by Ss using color versus monochrome imagery. This report describes the research methodology, the results obtained, and potential reasons for the results; it also discusses the plans for continuing research in this area, and assesses the implications these findings may have on teleoperated vehicle designs. 11 refs., 7 figs.

32497 (UCRL–102927) **A hierarchical approach to large space structure control.** Young, K.D. Lawrence Livermore National Lab., CA (USA). 15 Jan 1990. 12p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CONF-9005174–1: International conference on dynamics of flexible

structures in space, Cranfield (UK), 15-18 May 1990). Order Number DE90010681. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Controlled Component Synthesis (CCS) is a CSI approach to decentralized control of large structures which was developed by the author in 1987. In the CCS process, instead of following the conventional control system design path which begins with a model of the open loop plant, the controlled plant is assembled from controlled components for which the modeling phase and the control design phase are integrated at the component level. In this paper, a hierarchical approach to large space structure control which utilizes the CCS process repeatedly in a multi-level setting is presented. 17 refs., 12 figs.

3203 Industrial and Agricultural Processes

Refer also to citation(s) 32284, 32450, 32701, 32702, 33106, 33189

32498 (AFME-FR–11) **Maintenance and energy conservation - a pratical guide for energy managers and maintenance engineers.** Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1986. 53p. (In French). Order Number DE90790632. Available from NTIS (US Sales Only), PC A04/MF A01.

This pratical guide gives some recommendations concerning the maintenance and energy conservation functions aiming at the optimization of the energetic installations and equipments in industry: vapour production (control and maintenance of the boiler, of the burner, etc.), vapour and hot water distribution, industrial space heating and ventilation, compressed air production and distribution, electric power distribution and utilization (transformers, motor), energy conservation in lighting system, energy consumption diagnosis.

32499 (ANL/ESD–3) **Magnetic heat pumps.** Giese, R.F. Argonne National Lab., IL (USA). Energy Systems Div. Feb 1990. 85p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. Order Number DE90010305. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The effect of the development of high-temperature superconductors on the use of magnetic heat pumps was evaluated for two applications: refrigeration for commercial food processing and industrial production of hot water or low-quality steam. Background discussion are included on magnetic heat pumps and their operation and on the selection of the two applications that were evaluated. The design of magnetic heat pumps and how designs will be affected by the use of high-temperature superconductors are analyzed. The heat pump designs used in the evaluations were a Brayton cycle with an active magnetic regenerator and a Brayton cycle with external recuperation. The economics of the active magnetic regenerator design are compared with conventional vapor-compression devices for the two applications. 30 refs., 18 figs., 22 tabs.

32500 (BISI–26649) **Utilization of waste heat in sintering process.** Ponevac, J. (Hutny Project, Kosice (CS)); Liba, B.; Majercakova, A. Metals Society, London (UK). British Industrial and Scientific International Translation Service. 1986. 17p. Translation of Hutn. Listy, (1986), v.41(8) p. 546-551. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

Translation of Hutn. Listy, (1986), v.41(8) p. 546-551.

Sintering is a technology which requires large amounts of energy and hence every effort has been made recently to decrease the energy requirements by introducing various technical measures, especially waste heat utilization. Laboratory-scale results of sintering by blowing hot air through the sinter bed and a project for utilization of the sensible heat produced by returning the heated air obtained during sinter cooling back to the sintering process are described. (author).

32501 (BISI–26680) **Utilization of the residual energy of integrated iron- and steelworks: Technical and economic limits.** Aichinger, H.M.; Hoffman, G.W.; Poettken, H.-G.; Reinitzhuber, F.; Seeger, M.; Trappe, K. Metals Society, London (UK). British Industrial and Scientific International Translation Service. 1986. 27p. Translation of Stahl Eisen, (1986), v.106(20) p. 31-40. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

Translation of Stahl Eisen, (1986), v.106(20) p. 31-40.

Along with the optimization of thermal and metallurgical processes and the avoidance of energy-consuming operations, energy recovery and waste heat utilization are crucial factors in the pursuit of rational energy exploitation. In a status quo analysis of the entire production sequence from the coking plant, sinter and blast furnace plant, and basic oxygen steelworks to the continuous caster and rolling mill furnaces, the following opportunities for utilizing residual energy are discussed with reference to the energy balances of state-of-the-art plants: coke dry quenching, combined coke dry quenching and coal preheating, enthalpy of the the crude coke oven gas, sinter cooling, increased internal use of BF gas and waste heat, compression energy and enthalpy of the BF gas, pressure balancing gas from the hoppers at the furnace top, slag enthalpy, converter gas recovery, enthalpy of continuously cast material and increased utilisation of the waste gas enthalpy of rolling mill furnaces. In the technical realisation of residual energy conversion plants, many boundary conditions must be considered. These are discussed in conclusion. (author).

32502 (CONF-900102–5) **Technical and economic evaluation of diesel engine with oxygen enrichment and water injection.** Cole, R.L. (Argonne National Lab., IL (USA)); Sekar, R.R.; Marciniak, T.J.; Stodolsky, F. Argonne National Lab., IL (USA). [1990]. 8p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From 13. energy-sources technology conference and exhibition; New Orleans, LA (USA); 14-18 Jan 1990. Order Number DE90009723. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Technical and economic feasibility of diesel engines for stationary cogeneration applications using oxygen-enriched combustion air, water injection, and low-grade fuels was examined. The effects of these modifications on the diesel engine were studied with a computer simulation: results are presented in a companion paper. Four methods of oxygen enrichment, purchases LOX, cryogenic separation, pressure-swing adsorption (PSA), and membrane enrichment (ME) were investigated. Two of these methods, PSA and ME, are particularly amenable to integration with a stationary engine. After the technical evaluation was completed, the economic performance of the options was analyzed. Results show that the economic viability of the system depends primarily on switching to a cheaper, low-grade fuel; the optimum oxygen enrichment is the minimum that will enable the engine to burn the low-grade fuel. Economic benefit also derives from increased power production. Both of the methods that can be integrated with the engine show economic benefits, but one is more attractive that the other. Cryogenic separation systems are generally too large to be technically feasible for this application. The use of low-grade fuels, oxygen enrichment, and water injection affect ignition delay and combustion times, cylinder temperatures and pressures, and emissions (especially smoke, particulates, and NO_x). There appears to be an optimum combination of these parameters that will allow short ignition delay, reasonable cylinder temperatures and pressures, and low emissions.

32503 (CONF-900742–1) **Initial parametric results using CYCLEZ—An LMTD-specified, Lorenz-Meutzner cycle refrigerator-freezer model.** Rice, C.K.; Sand, J.R. Oak Ridge National Lab., TN (USA). [1990]. 24p. Sponsored by U.S. DOE Conservation & Renewable Energy; Environmental Protection Agency. DOE Contract AC05-84OR21400. From International compressor engineering conference, USNC/IIR-Purdue refrigeration conference and ASHRAE-Purdue CFC conference; West Lafayette, IN (USA); 17-20 Jul 1990. Order Number DE90010146. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A computer model representing a two-evaporator, two-intercooler refrigerator-freezer operating at steady-state with nonazeotropic refrigerant mixtures (CYCLEZ) has been developed at Oak Ridge National Laboratory (ORNL). This model is being used to assess the effects of system design and operating parameters on the cycle performance of a refrigerator-freezer designed around the Lorenz-Meutzner (L-M) circuit. Separate evaporators for the freezer and fresh-food compartments are modeled, as well as two intercoolers

that subcool liquid refrigerant from the condenser by heat transfer with low-pressure refrigerant. The CYCLEZ refrigerator/freezer model is derived form the CYCLEZ heat-pump model developed originally by the National Institute of Standards and Technology (NIST). CYCLEZ currently uses the Carnahan-Starling-DeSantis (CSD) equation-of-state to compute refrigerant thermodynamic properties , so that new refrigerants can easily be added. Condenser and evaporator heat-exchanger performance are defined by user-specified overall LMTDs which allow equivalent heat-exchanger sizing per unit refrigeration load to be maintained for different refrigerant mixtures. A more consistent formulation of overall heat-exchanger LMTD is applied across the condenser superheated and two-phase regions as well as over the two evaporators. Source and sink conditions are specified in terms of inlet and outlet temperatures of the external fluid streams. Intercooler high-side (subcooling) δ Ts and relative fresh-food-to-freezer load ratio are also user-specified. These features make this model well suited for evaluating the optimal thermodynamic cycle requirements of the five heat exchangers used in the L-M refrigerator/freezer circuit. 13 refs., 6 figs., 1 tab.

32504 (DOE/ID–10281) **Physical modeling of bubble phenomena, electrolyte flow and mass transfer in simulated advanced Hall cells: Final report.** Evans, J.W. (California Univ., Berkeley, CA (USA). Dept. of Materials Science and Mineral Engineering); Shekhar, R. EG and G Idaho, Inc., Idaho Falls, ID (USA); California Univ., Berkeley, CA (USA). Dept. of Materials Science and Mineral Engineering. Mar 1990. 223p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC07-76ID01570. Order Number DE90010640. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

The Hall-Heroult cell, used for the production of aluminum, is a major consumer of electrical energy. The aluminum industry and the Department of Energy have long had an interest in improving the cell so as to reduce the quantity of electricity consumed which is presently approximately twice the theoretical minimum. This interest has taken the form of materials research and development aimed primarily at inert anodes (to replace the consumable carbon anodes presently used) and wettable refractory cathodes (on which a thin film of aluminum will form rather than the pool of aluminum in existing cells). There is a reasonable expectation that these materials will become available this decade, perhaps early in this decade, and the question of how a cell is to be designed using them must be addressed. It was with that question that the present project was concerned. The objectives of this project were to define mathematically dimensionless numbers, using physical models and and specialized apparatus and selected working fluids, to develop quantitative correlations of dimensionless groups, to recommend anode designs, and to predict advanced (low-energy) Hall-Heroult cell performance. 21 refs., 95 figs.

32505 (EGG-M–90162) **Alternative solvents/technologies for paint stripping: Phase 1.** Tsang, M.N.; Harris, T.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 11p. Sponsored by U.S. Department of Defense. DOE Contract AC07-76ID01570. (CONF-9004182–2: 17. environmental symposium: environmental compliance and enforcement at DOD installations in the 1990's, Atlanta, GA (USA), 17-20 Apr 1990). Order Number DE90010981. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Paint stripping is a necessary part of maintenance at US Air Force Air Logistics Centers. The Waste from Air Force paint stripping operations contains toxic chemicals that require special handling and disposal at considerable cost. Solvent emissions of volatile organic compounds (VOCs) into the atmosphere are another source of pollution. These wastes are hazardous to the environment and to operating personnel, and are now regulated by the US Environmental Protection Agency, which can impose fines for discharges that exceed the established limits. This report describes the research project titled Alternative Solvents/Technologies for Paint Stripping being conducted by the Idaho National Engineering Laboratory for the Engineering and Services Center at Tyndall Air Force Base. This report also includes the results obtained in Phase 1. 8 refs., 3 tabs.

32506 (GAO/NSLAD–90-11) **Hazardous waste: Attention to DOD inventories of hazardous materials needed.** General Accounting Office, Washington, DC (USA). National Security and International Affairs Div. Dec 1989. 34p. Available from US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877 (USA).

This paper presents a GAO report. The Department of Defense is a major generator of hazardous waste. Since 1984 all hazardous waste generators have been required to have minimization programs. GAO found that DOD's current inventory practices do not minimize the amount of unused hazardous materials that are transferred to the disposal process.

32507 (OAF/AE–Agdex-440/717.3) **Retrofit of a hog finishing barn to natural ventilation.** Trivers, D. (Univ. of Guelph, Guelph, ON, (Canada)). Ontario Ministry of Agriculture and Food, Toronto, ON (Canada). Agricultural Energy Centre. Nov 1986. 20p. (MICROLOG–90-02015). Available from PC Ontario Agriculture and Food, Consumer Information Centre, 801 Bay St, Main Floor, Toronto, ON, CAN M7A 2B2; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A mechnical ventilation system in a hog finishing barn was converted to cathedral ceiling type natural ventilation with a continuous ridge outlet and the modified open front type barn. The 18 m width is greater than that of typical naturally ventilated barns. The barn was monitored to determine if the system can provide adequate air mixing and distribution. Results indicate the system provides good winter humidity control and summer temperature control and the health and performance of the feeder hogs improved. 7 refs., 11 figs., 1 tab.

32508 (PB–90-183211/XAB) **Diagnostic tools for reciprocating engine cogeneration systems. Phase 1, final report, June 1989-December 1989.** Kirkpatrick, J.F. Computational Systems, Inc., Knoxville, TN (USA). Jan 1990. 53p. Available from NTIS, PC A04/MF A01.

The report covers the first phase of a program undertaken to develop diagnostic and monitoring tools for gas-fueled reciprocating engines. Results of the work included development of an on-line oil quality sensor, development of an ignition monitoring technique, and preliminary testing of an integrated, microprocessor-based diagnostic system. Economic constraints, however, do exist for monitoring systems and they would only be viable for small engines if produced in large volumes. A modular approach to system installation would seem to allow application to the largest number of engines by allowing tailoring of system costs to the application.

32509 (PB–90-862962/XAB) **Recycling metal scrap. June 1970-January 1990 (A Bibliography from the COMPENDEX database). Report for June 1970-January 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 142p. Available from NTISPC N01/MF N01.

Supersedes PB–89-861629.

This bibliography contains citations concerning the processes, techniques, and benefits of recycling metal scrap. The recycling processes for aluminum, chromium, nickel, cobalt, lead, copper, and precious metals scrap are discussed. Recycling in the jewelry, electronics, milling, beverage, automotive, and aircraft industries is considered. Analyses of the current global scrap metal recycling trends are included. (This updated bibliography contains 362 citations, 21 of which are new entries to the previous edition.)

32510 (PB–90-863226/XAB) **Resource Conservation and Recovery Act (RCRA): Hazardous wastes. August 1978-March 1990 (A Bibliography from the NTIS data base). Report for August 1978-March 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 97p. Available from NTISPC N01/MF N01.

Supersedes PB–89-857270.

This bibliography contains citations concerning the Resource Conservation and Recovery Act. Citations cover the handling of hazardous waste, facility investigation, and updates and reviews of selected provisions of the act. Groundwater monitoring, landfill design, liner systems, and incineration standards are among the topics discussed. (This updated bibliography contains 182 citations, 35 of which are new entries to the previous edition.)

32511 (PNL–7309) **Fiscal year 1989 annual report for the Sensors Development Program: Inert Electrodes Program.** Windisch, C.F. Jr. (Pacific Northwest Lab., Richland, WA (USA)); Koski, O.H.; Stice, N.D.; Morgan, L.G.; Nikias, C.L. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 51p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. Order Number DE90010281. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Sensors Development Program is conducted at the Pacific Northwest Laboratory (PNL) for the US Department of Energy (DOE), Office of Industrial Programs (OIP). The work is being performed in conjunction with the Inert Electrodes Program at PNL. The objectives of the Sensors Development Program are to (1) investigate and develop methods of process monitoring/control for operating electrolytic cells and (2) determine safe operating conditions for the inert anodes. The majority of work in FY 1989 involved (1) evaluating Digital Signal Analysis (DSA) methods to monitor inert anode operation and to determine alumina concentration in both PNL bench-scale laboratory cells and the Prototype Inert Anode Test and (2) developing the reference anode against which inert anode voltage signals could be measured by the DSA-based or other methods. 3 refs., 14 figs., 2 tabs.

32512 **Waste minimization in historical perspective.** Colten, C.E. (Illinois Hazardous Waste Research and Information Center, Savoy, IL (US)). 739-744 of Proceedings of the 43rd industrial waste conference. Lewis Publishers, Chelsea, MI (USA) (1989). (CONF-8805322–: 43. industrial waste conference, West Lafayette, IN (USA), 10-12 May 1988).

The term waste minimization is one of recent coinage, yet the practices which characterize this policy have a lengthy history. As currently used, waste minimization refers to efforts aimed at reducing the flow of wastes from manufacturing practices and accomplishing it with a margin of profit. Practices that fall within this mode of waste management attack the waste problem at its source, either in the form of process modification, raw material changes, or waste recovery, not at the end of the sewer lines. Despite the recent interest in waste minimization, industry has considered waste recovery a viable, if not always successful, means of handling unwanted by-products since the nineteenth century. Hirschorn has recently suggested that direct federal economic incentives would encourage improved private sector management of hazardous wastes. Historically, the modest improvements in industrial waste management have been driven only in part by economic concerns. This chapter reviews the technical and trade literature on industrial waste treatment from 1900 through the 1960s in an attempt to identify other factors which encouraged waste minimization in the past. It chronicles the efforts taken to reduce waste streams and recount the difficulties encountered in making such programs successful. While this survey is not complete, nor does it analyze the technological developments allowing for waste recovery, it will trace the motivations for waste minimization, consider the general methods of reducing industrial pollution, and examine the obstacles to effective implementation of waste reduction practices.

3206 Municipalities and Community Systems

Refer also to citation(s) 32330

32513 (CONF-900676–5) **Results of emissions and ash testing in full-scale co-combustion tests of binder-enhanced dRDF pellets and high-sulfur coal.** Ohlsson, O.O. (Argonne National Lab., IL (USA)); Livengood, C.D.; Daugherty, K.E. Argonne National Lab., IL (USA). 14 May 1990. 29p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From 83. annual meeting and exhibition of the Air and Waste Management Association; Pittsburgh, PA (USA); 24-29 Jun 1990. Order Number DE90011118. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

As existing landfills become filled to capacity and new landfills become more costly to site, the development of alternative disposal methods of municipal solid wastes (MSW) is becoming critical. In addition, the refuse being buried contains considerable quantities of energy that could potentially replace conventional fossil fuels. Some of the main problems of using MSW as a feedstock have been variability, biological and chemical instability, and poor fuel quality. An improved method for turning MSW into an environmentally safe and economical fuel has recently been developed. Recyclable metals, glass and some plastics are mechanically and manually separated from the waste. The remaining (combustible) fraction is combined with a calcium hydroxide binding additive, and formed into cylindrical pellets. These pellets are dense and odorless, can be stored for up to three years without significant biological or chemical degradation, and are easily transported. These pellets have been successfully confined with coal in existing spreader-stoker combustors. Other benefits include significant reductions of sulfur dioxide (SO_2), nitrogen oxides (NO_x) and CO_2 in the flue gases, and the trapping of the chlorine combustion products (such as HCl) that are formed during the combustion process from the remaining plastics in the refuse. This paper describes the b-dRDF pellet/coal cofiring tests, emission and ash samples collected, analyses that were conducted on these samples, and study conclusions. 6 refs., 11 figs., 13 tabs.

32514 (CONF-9005169–1) **Targets of opportunities for plastics recycling and source reduction.** Curlee, T.R. Oak Ridge National Lab., TN (USA). [1990]. 25p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Recycling-plas V conference; Washington, DC (USA); 23-24 May 1990. Order Number DE90010716. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper summarizes the results of two recent studies to identify and assess "targets of opportunity" for additional recycling and source reduction of plastic wastes. The targets of opportunity are discussed in terms of the quantities of plastics wastes that might be affected, the relevant supply-side and demand-side constraints that must be overcome before these targets can be met, and the degree to which meeting these targets might be facilitated by government sponsored incentive programs or other regulatory measures. Several hypothetical scenarios are developed that depict various supply-side and demand-side conditions. In some cases, the supply-side and demand-side assumptions are consistent with current technical, economic, institutional, and regulatory conditions. In other cases, particularly with respect to supply-side constraints, the assumptions represent significant shifts in the ways plastics are collected and processed in the United States. The quantities and types of plastics that could be recycled or source reduced, given the hypothetical conditions, are estimated. 13 refs., 3 figs.

32515 (NBES–2055) **Energy conservation through mechanical dehumidification Miramichi Valley High School pool, Newcastle, N.B.: Final report.** Davis, K.A. (Enerplan Consultants Ltd. (Canada)). New Brunswick Energy Secretariat, Fredericton, NB (Canada). Feb 1985. 43p. (CE–02975). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

A detailed analysis of the results of the energy project on the Miramichi Valley High School (Newcastle, New Brunswick) swimming pool shows that the energy retrofit was a success. The heat loss from pool water to air due to evaporation can be reclaimed by drying the air. This is done by passing the air through a dehumidifier coil. Here, the air is cooled below its dew point and the water condensed. The heat reclaimed is absorbed by a mechanical refrigeration system and is used to reheat the pool water. The heat remaining in the refrigeration unit is used in the reheat coil to warm the air which has been cooled in the dehumidifier coil and to offset pool enclosure conduction losses. The dehumidifying heat pump heats the pool water and at the same time stabilizes humidity and temperature. The mercury lighting system was replaced with a mixture of high-pressure sodium and metal halide fixtures to improve the energy efficiency. The electric water heater, being the original pool heater, was left as a back-up system though it is actually not needed. The whole project has proved to be very energy-efficient, with savings of 60.1% on the heating and 33.3% on the lighting. This entailed annual savings of Can $21,400. The simple payback period is 4.5 y, although this would not be the same for every indoor pool. 15 figs., 6 tabs.

32516 (PB–90-178971/XAB) **Grid-interconnection requirements for small cogeneration systems. Final report,**

September 1985-December 1987. Iverson, J.R.; Vavrina, R.D. Onan Corp., Minneapolis, MN (USA). Sep 1987. 346p. Available from NTIS, PC A15/MF A02.

See also PB–90-178989.

This report describes the results of an investigation into the performance and cost of interconnection equipment and devices required when a small (40-800 kW gas-engine-driven generator sets) cogeneration installation exports power to the electric utility. Computer modeling and analysis was conducted and served as the basis for analyzing normal and abnormal system operating conditions, developing performance-based interconnection requirements, and evaluating alternative approaches to interconnection. Boundary constraints are established for interconnected cogeneration capacity as a function of cogenerator type (synchronous or induction), utility-circuit capacity, and cogenerator-installation location on the utility circuit that result in negligible impact to the utility system during any operating condition.

32517 (PB–90-178989/XAB) **Grid-interconnection requirements for small cogeneration systems - Appendix. Final report, September 1985-December 1987.** Iverson, J.R.; Vavrina, R.D. Onan Corp., Minneapolis, MN (USA). Dec 1987. 281p. Available from NTIS, PC A13/MF A02.

See also PB–90-178971.

This report describes the results of an investigation into the performance and cost of interconnection equipment and devices required when a small (40-800 kW gas-engine-driven generator sets) cogeneration installation exports power to the electric utility. Computer modeling and analysis was conducted and served as the basis for analyzing normal and abnormal system operating conditions, developing performance-based interconnection requirements, and evaluating alternative approaches to interconnection. Boundary constraints are established for interconnected cogeneration capacity as a function of cogenerator type (synchronous or induction), utility-circuit capacity, and cogenerator installation location on the utility circuit that result in negligible impact to the utility system during any operating condition.

33 ADVANCED PROPULSION SYSTEMS

Refer also to citation(s) 32473

3301 Internal Combustion Engines

Refer also to citation(s) 32112, 32113, 32120, 32508, 32837, 33073

32518 (PB–90-862863/XAB) **Engine turbochargers and superchargers. January 1983-January 1990 (A Bibliography from the COMPENDEX data base). Report for January 1983-January 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 169p. Available from NTISPC N01/MF N01.

Supersedes PB–87-863650.

This bibliography contains citations concerning turbochargers and superchargers used on diesel engines and internal combustion engines. Automotive applications, both foreign and domestic, are discussed and include gasoline, alcohol, and diesel fuels. Topics on efficiency, future trends, design features, fuel feed, operational descriptions, combustion, and specific engine designs are included. (This updated bibliography contains 396 citations, 220 of which are new entries to the previous edition.)

32519 (UCRL–102495) **Engine knock predictions using a fully-detailed and a reduced chemical kinetic mechanism.** Cowart, J.S. (Massachusetts Inst. of Tech., Cambridge, MA (USA)); Keck, J.C.; Heywood, J.B.; Westbrook, C.K.; Pitz, W.J. Lawrence Livermore National Lab., CA (USA). 13 Dec 1989. 23p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-7405-ENG-48. (CONF-900704–2: 23. Combustion Institute symposium on combustion, Orleans (France), 22-27 Jul 1990). Order Number DE90005992. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Two chemical kinetic models are used to interpret engine knock data obtained in a laboratory internal combustion engine. These consisted of a detailed kinetic model and a reduced kinetic model, both calibrated to describe engine conditions. Comparisons of both models with experimental results are discussed. Relationships between the reaction steps of the detailed and reduced models are examined in detail, and the relative strengths and weaknesses of the two approaches are discussed. 15 refs., 2 figs., 2 tabs.

32520 (UCRL–102496) **Combustion of n-butane and isobutane in an internal combustion engine: A comparison of experimental and modeling results.** Wilk, R.D. (Union Coll., Schenectady, NY (USA)); Pitz, W.J.; Westbrook, C.K.; Addagarla, S.; Miller, D.L.; Cernansky, N.P.; Green, R.M. Lawrence Livermore National Lab., CA (USA). 13 Dec 1989. 18p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-7405-ENG-48. (CONF-900704–3: 23. Combustion Institute symposium on combustion, Orleans (France), 22-27 Jul 1990). Order Number DE90005993. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

n-Butane and isobutane are used in a test engine to examine the importance of molecular structure in determining knock tendency. The experimental results are interpreted using a detailed chemical kinetic model. Temporally resolved samples were withdrawn from the combustion chamber, providing measured histories of the concentrations of a wide variety of reactant, olefin, carbonyl, and other intermediate and product species. Calculations show that RO_2 isomerization reactions are more important contributors to chain branching in n-butane oxidation than in isobutane oxidation. Chain branching in isobutane oxidation is dependent on H-atom abstraction reactions involving HO_2 and CH_3O_2 radicals that occur at higher temperatures than RO_2 isomerization reactions. Therefore, an isobutane mixture must be raised to a higher temperature than a n-butane mixture to achieve the same overall rate of reaction. 23 refs., 4 figs.

32521 **Ceramic valve development for heavy-duty low heat rejection diesel engines.** Weber, K.E.; Micu, C.J. *Ceramic Engineering and Science Proceedings (USA),* 10: 1254-1268 (Oct 1989). (CONF-890130–: 13. annual conference on composites and advanced ceramics, Cocoa Beach, FL (USA), 15-18 Jan 1989).

Monolithic ceramic valves can be successfully operated in a heavy-duty diesel engine, even under extreme low heat rejection operating conditions. This paper describes the development of a silicon nitride valve from the initial design stage to actual engine testing. Supplier involvement, finite element analysis, and preliminary proof of concept demonstration testing played a significant role in this project's success.

32522 **Ceramic port shields cast in an iron engine head.** Hakim, N.S.; Groeneweg, M.A. *Ceramic Engineering and Science Proceedings (USA),* 10: 1304-1314 (Oct 1989). (CONF-890130–: 13. annual conference on composites and advanced ceramics, Cocoa Beach, FL (USA), 15-18 Jan 1989).

Silicon nitride exhaust and intake port shields have been successfully cast into a gray iron cylinder head of a heavy duty diesel single cylinder research engine. Careful design considerations, finite element, and probability of survival analyses indicated viability of the design. Foundry experience, NDE, and failure investigations are reported.

3303 Electric-Powered Systems

Refer also to citation(s) 32438, 32439

32523 (EGG-M–90200) **Application of ultracapacitors in electric vehicle propulsion systems.** Burke, A.F. (EG and G Idaho, Inc., Idaho Falls, ID (USA)); Hardin, J.E.; Dowgiallo, E.J. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 18p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC07-76ID01570. (CONF-9006146–6: 34. international power sources symposium, Cherry Hill, NJ (USA), 25-28 Jun 1990). Order Number DE90010884. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Simulations of electric vehicles utilizing hybrid power sources showed that load leveling the main storage battery is a promising approach for reducing the design power requirements for the battery and increasing battery life. Significantly increased vehicle range should also result for batteries, which have been optimized

for energy density at the lower peak power requirements made possible by load leveling. Consideration of the characteristics of ultracapacitors and bipolar lead-acid pulse batteries for the pulse power device indicate either device could be used, but the efficiency of the system would be greater by about 10% using the ultracapcitors.

32524 (PB–90-183062/XAB) **Federal regulations needing amendment to stimulate the production and introduction of electric/solar vehicles. A report to Congress, January 1990.** Transportation Systems Center, Cambridge, MA (USA). Jan 1990. 149p. Available from NTIS, PC A07/MF A01.

The categories of federal regulations considered for the report were safety, emissions, and consumer protection. It was found that no current regulations act as a barrier to the introduction of electric vehicles (EVs) into commerce. The present stimulatory regulation, the Corporate Average Fuel Economy (CAFE) credit for EVs, is not sufficient to bring EVs into production, but should be maintained. The petroleum-equivalency factors in this regulation expired in 1987, but are currently being updated by the Department of Energy. There is a strong consensus among the various groups engaged in EV development and research, that automobile manufacturers retain the option to include equivalent petroleum-based fuel economy values for EVs in their CAFE (10 CFR Part 474), provided EVs are not used to determine the manufacturer's capability for purposes of establishing a fuel-economy standard. No future regulations which could be promulgated under standing legislations would be sufficient to accelerate the introduction of EVs.

3308 Alternative Fuels

Refer also to citation(s) 32048, 32058, 32059, 32060, 32061, 32062, 32063, 32064, 32065, 32078, 32113, 32837

32525 (CONF-9002120–1) **A summary of prospects for methanol vehicles in the United States.** Larsen, R.P. Argonne National Lab., IL (USA). [1990]. 10p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From National symposium on methanol vehicles; Tokyo (Japan); 6-8 Feb 1990. Order Number DE90009719. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Interest in alternatives to petroleum as fuel for the US transportation system has been increasing steadily over the last 10 years. Initiatives from the federal and state governments have advanced the likelihood of the use of alternative fuels in the US in significant volumes in the 1990's. In a rare convergence of governmental and industrial perspectives, methanol has emerged as the most likely alternative fuel to displace large quantities of petroleum as a transportation fuel. Methanol has attained this position because of its favorable economics from infrastructure, vehicle conversion, and production standpoints. In addition, the necessarily lengthy transition period for any alternative fuel is facilitated using methanol, a liquid fuel with a great many similarities to gasoline and diesel fuel. The environmental benefits from a transition to alternative fuels, and from methanol in particular, have emerged as the largest motivation to begin a transition to a non-petroleum fuel. This paper will summarize recent developments in alternative fuel policy, research and development, and legislative initiatives in the US, highlighting the leading position of methanol fuel.

32526 (PB–90-187964/XAB) **Prospects for alternatives to liquid-petroleum-vehicle fuels. Summary of the annual GRI (Gas Research Institute) energy seminar (10th) for the GRI board of directors and advisory council. Held in Vail, Colorado on August 7-9, 1989. Topical report.** Farrell, M.D. Gas Research Inst., Chicago, IL (USA). Aug 1989. 58p. Available from NTIS, PC A04/MF A01.

Gas Research Institute (GRI) conducts an annual energy seminar for its Board of Directors and Advisory Council on issues of importance to the gas industry. The summary of the Tenth Annual GRI Energy Seminar, Prospects for Alternatives to Liquid Petroleum Vehicle Fuels reports on the mix of viewpoints exchanged on market entry barriers, technology readiness, and consumer awareness and acceptance issues associated with vehicles powered by any fuel other than the traditional vehicle fuels of gasoline or diesel fuel. Presentations by gas industry executives, federal government staff, bus and car manufacturers, and GRI staff are summarized in the report. The seminar participants emphasized the particular suitability of compressed-natural-gas technology for fleet vehicles that can be serviced at central refueling stations. They found this potential to be consistent with GRI's strategy of first targeting technologies applicable to transit buses, followed by R&D on medium- and heavy-duty fleet vehicles such as delivery vans and refuse haulers.

35 ARMS CONTROL

32527 (PB–90-189168/XAB) **Strategic Defense Initiative Organization. Directive.** Furtner, R. Office of the Secretary of Defense (Administration and Management), Washington, DC (USA). 4 Jun 1987. 10p. (DOD-D–5141.5). Available from NTIS, PC A02/MF A01.

The Directive reissues DoD Directive 5141.5, February 21, 1986, and establishes, pursuant to the authority vested in the Secretary of Defense under Title 10, United States Code, and National Security Decision Directive 119, January 6, 1984, the Strategic Defense Initiative Organization as an agency of the Department of Defense with responsibilities, functions, relationships, and authorities as prescribed herein.

3503 Verification

32528 (PSR–1952) **A decision-analysis process to support verification technology research and development.** McManus, T.P. Pacific-Sierra Research Corp., Arlington, VA (USA). May 1989. 56p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC01-88DP50066. Order Number DE90010841. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report describes the systematic decision-analysis process developed by Pacific-Sierra Research Corporation (PSR) to evaluate all pertinent factors in the verification technology R&D programmatic decisionmaking process. This decision-analysis process is aided by a commercial software program that allows quantitative evaluation of alternatives based on qualitative judgements of evaluators. 25 figs.

32529 (UCRL–52000-90-3) **Energy and Technology Review, March 1990.** Burnham, A.K.; Corey, C.M.; de Vore, L.; Gleason, K.; Sanford, N.M.; Taft, S.O. (eds.). Lawrence Livermore National Lab., CA (USA). 1990. 38p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008230. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Energy & Technology is published by Lawrence Livermore Laboratories monthly to report on progress for the several programs currently being conducted. Specific articles are: Materials Engineer to Astronaut; Improving Composite Materials through Mechanistic Cure Modeling; A Test of Newton's Inverse-Square Law of Gravity; A Decision Framework for Verifying Compliance with Test-Limitation Treaties; and Discrimination of Nuclear Explosions and Earthquakes. 26 figs. (FSD)

36 MATERIALS

32530 (UCRL-ID–103480) **Materials Fabrication Division/ Precision Engineering Program Combined Bibliography (1970–1989).** Stowers, I.F. Lawrence Livermore National Lab., CA (USA). Mar 1990. 103p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010286. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The Combined Bibliography assembles in one document the 1970–1989 reports, conference proceedings, and publications authored by members of the Materials Fabrication Division and the Precision Engineering Program. It was prepared from data recovered from the LLNL Library's and report database and from DOE's Energy Database using Pro-Cite. The bibliography is divided into three parts: publication list by author, publication list by key words, and fully annotated references.

3601 Metals and Alloys

Refer also to citation(s) 32044, 32045, 32200, 32321, 32336, 32338, 32356, 32405, 32511, 32617, 32644, 32649, 32665, 32719, 32749, 32762, 32856, 32873, 32897, 33013, 33188, 33628, 33634

32531 (CBPF-NF–046/89) **Effects of Al substitution by Fe in $CeAl_2$.** Takeuchi, A.Y.; Cunha, S.F. da. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 18p. Order Number DE90627843. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Magnetization and electrical resistivity measurements of the $CeAl_2$ with Al substitution by Fe up to 10% at Fe show that the competition between the increasing Kondo effect and the antiferromagnetism persists. Change of the electronic density is followed by a decreasing Neel temperature and an increasing residual electrical reistivity. The probable appearance of ferromagnetism of the Ce moments, at intermediate temperature range, is discussed. The small decrease of the lattice parameter with Fe concentration or the magnetic behaviour do not show evidence of valence changes in the Ceion. (author).

32532 (CEA-CONF–9871) **Optical coatings processed by CO2 laser sintering.** Floch, H.G. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (FR)); Boittiaux, P.J.; Priotton, J.J.; Brusasco, R.M. CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France). 1989. 17p. (CONF-8904349–: 16. international conference on metallurgical coatings, San Diego, U (USA), 17-21 Apr 1989). Order Number DE90792949. Available from NTIS (US Sales Only), PC A03/MF A01.

A method of processing optical coatings, applying CO2 laser sintering, is presented. Si02 and Si02 doped Ti02 sol-gel coatings are sintered. The laser sintering facility is described and the preliminary results are discussed. The experiments are performed in order to determine the parameters leading to a high surface temperature with no substrate distortion. A continuous wave, 5000 watt Rafin-Sinarlaser system is used. A diaphrogma is used to reduce the maximum power of the laser to 1700 watt. The sample is translated across the beam using a micro-control translation stage platform. The speed of the stage vary between 1 and 20 mm/s. The results show that this method leads to clear, non scattery paths. The method of processing laser resistant coatings seems promising for the conceiving of mirrors.

32533 (CEA-DAS–540) **Prediction of the brittle-ductile transition temperature shift, from irradiation experiments obtained in France.** Miannay, D. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (FR). Dept. d'Analyse de Surete); Dussarte, D.; Soulat, P. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete. Oct 1988. 40p. (In French). (CONF-880613–: 14. international symposium on effects of radiation on materials, Andover, MA (USA), 27-29 Jun 1988). Order Number DE90792882. Available from NTIS (US Sales Only), PC A03/MF A01.

In integrety - evaluation studies of the nuclear-reactor vessel, the toughness of component materials is given by a reference curve, which represents the lowest level of the toughness possible values, as a function of the temperature. Its temperature-scale position is given by the null ductility temperature. In non-irradiated conditions, the temperature of the vessel materials is experimentally obtained. To take into account the irradiation effect, a shift of this temperature, given by the correlations where chemical composition and neutronic dose are included, is considered. Up to date correlations, settled for materials brittler than those applied in the French program, are called in question again. A correlation between results obtained in France since 1973, for base metals and welded joints is given. The behavior of CHOOZ vessel, under irradiation conditions, is discussed.

32534 (CEA-R–5486) **Heat treatments influence on mechanical properties of zircaloy 4 - particular study of fatigue structures.** Autissier, L. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Technologie; Paris-6 Univ., 75 (France). Feb 1989. 376p. (In French). Order Number DE90792919. Available from NTIS (US Sales Only), PC A17/MF A01.

The aim of this study was to improve the knowledge of the out-of-pile mechanical behaviour of Zircaloy 4. A bibliographical study was carried out in relation to phase transformations, resulting precipitation, strain mechanism, and dislocation structures induced by cyclic loadings. - The first approach was based on tensile, fatigue, and creep tests in order to establish design rules and to compare the alloy after 5-mn treatment at 1030^0 C followed by quenching the alloy after a 2-hours recrystallisation at 650^0 C. - The second was based on structural damage resulting from cyclic loadings and dislocation structures. Such damage is closely connected with crack depth, and not with crack density. Fatigue substructures depend on stress amplitude and take the form of dislocation bundles, walls, cells, and labyrinth-like structures. Such configurations exist in both forms of Zircaloy-4. They are similar to those exhibited in face-centered cubic metals. The last step consisted in an analysis of the various design rules, trying to define the effects of microstructure and texture. It was noted that the microstructure influenced cracking processes, whereas texture affected deformation mechanisms.

32535 (CEA-R–5508) **Phase transition in a shock loaded 304 stainless steel.** Naulin, G. CEA Centre d'Etudes de Bruyeres-le-Chatel, 91 (France); Poitiers Univ., 86 (France). Nov 1989. 184p. (In French). Order Number DE90793016. Available from NTIS (US Sales Only), PC A09/MF A01.

Systematic shock recovery experiments have been performed on a Z2 CN 18-10 stainless steel (304 AISI), shocked in a pressure range of 5-13 GPa. The pulse durations lay between 0.1 μs and 2 μs. The phases transformation γ (fcc) to α' (bcc) is studied. The evolution of microstructures, the nucleation and the coalescence of α' phase embryos have been observed by TEM examinations. Quantitative measurements of the α' phase allow to plot diagrams of transformed phase versus shock pressure and pulse duration. Manganin gages allow to know the pressure evolution during the impact. The Olson and Cohen model describes the development of the α' phase versus the plastic deformation. An adaptation of this model has been developed, which describes the development of the α' phase versus shock pressure and pulse duration. Theoretical laws give a good correlation with experimental results.

32536 (CONF-900466–34) **Morphological and structural characterization of the spinodal decomposition of Fe-Cr alloys.** Cerezo, A. (Oxford Univ. (UK). Dept. of Materials); Hetherington, M.G.; Hyde, J.M.; Miller, M.K. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90010496. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The position sensitive atom-probe (POSAP) is capable of extremely high resolution (sub-nanometer) microanalysis. Its 3-dimensional capabilities are unique and offer a new opportunity to study the topology and structure of materials. This paper is an initial overview of the new types of parameters and analysis that this technique makes possible. 5 refs., 8 figs.

32537 (CONF-900466–37) **Au-Ge-Ni-Ti ohmic contacts on gallium arsenide.** Alexander, K.B. (Oak Ridge National Lab., TN (USA)); Stobbs, W.M. Oak Ridge National Lab., TN (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90011064. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The influence of titanium additions on the microstructure of Au–Ge–Ni ohmic contacts on gallium arsenide has been evaluated. Sequentially deposited layers of Ge, Au and Ni were topped with a titanium layer. The titanium formed a native titanium oxide on the upper surface of the contact which helped to maintain a continuous film during the anneal. Both the as-deposited and the annealed microstructures were studied with the use of electron microscopy techniques. In order to examine thoroughly the various phases which form in the annealed contact, unique specimen preparation procedures were used to fabricate a single plan-view specimen in which it was possible to examine the microstructure at various depths. 13 refs., 9 figs.

32538 (CONF-900623–7) **Irradiation effects on impact behavior of 12Cr-1MoVW and 2 1/4Cr-1Mo steels.** Klueh, R.L.; Alexander, D.J. Oak Ridge National Lab., TN (USA). [1990]. 26p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 15. symposium on effects of radiation on materials; Nashville, TN (USA); 17-21 Jun 1990. Order Number DE90011075. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Charpy impact tests were conducted on 12CR-1MoVW steel after irradiation in the Fast Flux Test Facility (FFTF) and the Oak Ridge Research Reactor (OOR). One-half-size and one-third-size Charpy specimens were irradiated in FFTF at 365°C. After irradiating half-size-specimens to ~10 and 17 dpa, a shift in ductile-brittle-transition temperature (DBTT) of 160°C was observed for both fluences, indicating a saturation in the shift. A shift DBTT of 151°C was observed for the third-size specimens after irradiation to 10 dpa. Third-size specimens of 12Cr–1MoVW steel irradiated ~7 dpa in the ORR at 330 and 400°C developed shifts in DBTT of 200 and 120°C, respectively, somewhat above and below the shifts observed after irradiation at 365°C in FFTF. This correspondence of results in the mixed-spectrum ORR and the fast-spectrum FFTF is in marked contrast to large differences observed between specimens irradiated in the mixed-spectrum High Flux isotope Reactor and the fast spectrum Experimental Breeder Reactor. The first data on the effect of fast reactor irradiation on the impact behavior $2\frac{1}{4}$ CR–1Mo steel were obtained. Third-size specimens were irradiated in FFTF to ~10 dpa at 365°C. An increase in DBTT of 170°C was observed, similar of the shift observed for 12Cr–1MoVW steel following comparable irradiation. The reduction in the upper-shelf energy for the $2\frac{1}{4}$ Cr–1Mo steel was less than that observed for 12Cr–1MoVW steel. Because of the low DBTT of unirradiated $2\frac{1}{4}$ Cr–1Mo steel, the DBTT after irradiation remained below that for 12Cr–1MoVW steel.

32539 (CONF-900623–8) **Effects of internal hydrogen on the vacancy loop formation probability in Al.** Bui, T.X. (Illinois Univ., Urbana, IL (USA). Dept. of Materials Science and Engineering); Sirois, E.; Robertson, I.M.; Kirk, M.A. Argonne National Lab., IL (USA). Apr 1990. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38;AC02-76ER01198. From 15. symposium on effects of radiation on materials; Nashville, TN (USA); 17-21 Jun 1990. Order Number DE90011114. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The effect of internal hydrogen on the formation of vacancy dislocation loops from heavy-ion generated displacement cascades in Al has been investigated. Samples of high-purity aluminum and aluminum containing 900 and 1300 appM of hydrogen were irradiated at room temperature with 50 keV Kr+ ions. The ion dose rate was typically 2×10^{10}ions cm^{-2} sec^{-1} and the ion dose was between 10^{11} and 10^{13} ion cm^{-2}. Under these irradiation conditions, dislocation loops were observed in all compositions, although the formation probability was relatively low (less than 10 percent of the displacement cascades produced a vacancy loop). The loop formation probability was further reduced by the presence of hydrogen. No difference in the geometry or the size of the loops created in the hydrogen free and hydrogen charged samples was found. These results are difficult to interpret, and the explanation may lie in the distribution and form of the hydrogen. To account for the large hydrogen concentrations and from calculations of the energy associated with hydrogen entry into aluminum, it has been suggested that the hydrogen enters the aluminum lattice with an accompanying vacancy. This will create hydrogen-vacancy complexes in the material; two dimensional complexes have been detected in the hydrogen-charged, but unirradiated, samples by the small-angle x-ray scattering technique. The possibility of these complexes trapping the vacancies produced by the cascade process exists thus lowering the formation probability. However, such a mechanism must occur within the lifetime of the cascade. Alternatively, if a displacement cascade overlaps with the hydrogen-vacancy complexes, the lower atomic density of the region will result in an increase in the cascade volume (decrease in the local vacancy concentration) which will also reduce the loop formation probability.

32540 (CONF-900623–9) **Cascade collapse in copper and nickel.** Vetrano, J.S. (Illinois Univ., Urbana, IL (USA). Dept. of Materials Science and Engineering); Robertson, I.M.; Averback, R.S.; Kirk, M.A. Argonne National Lab., IL (USA). Apr 1990. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38;AC02-76ER01198. From 15. symposium on effects of radiation on materials; Nashville, TN (USA); 17-21 Jun 1990. Order Number DE90011115. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In-situ TEM studies of the development of the damage structure produced by heavy ion irradiations have been performed in copper and nickel to investigate the possibility that melting occurs in local regions within displacement cascades. These experiments reveal that as the ion dose increases additional loops form from isolated displacement cascades, but more surprisingly some fo the pre-existing loops are annihilated, change position, size and/or Burgers vector. It was also found that the probability for loop formation and the defect image size are greater in copper than in nickel even at temperatures well below stage 3. It will be demonstrated that these observations provide supporting evidence, albeit indirect, that local melting occurs within the cascade core. These results will be compared to the molecular dynamic computer simulations of the damage created by low energy self-ions in copper and nickel. 15 refs., 4 figs.

32541 (CONF-900623–10) **Role of melting temperature on the properties of displacement cascades.** Smalinskas, K. (Illinois Univ., Urbana, IL (USA). Dept. of Materials Science and Engineering); Robertson, I.M.; Averback, R.S.; Kirk, M.A. Argonne National Lab., IL (USA). Apr 1990. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38;AC02-76ER01198. From 15. symposium on effects of radiation on materials; Nashville, TN (USA); 17-21 Jun 1990. Order Number DE90011106. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The defect structure produced in Cu-Ni alloys by room temperature heavy-ion irradiation have been investigated by TEM. This system exhibits complete solid solubility over the entire composition range and therefore allows the role of melting temperature on the properties of displacement cascades to be assessed. The probability of a dislocation loop forming in the Cu-Ni alloy system is highest in pure Cu and decreases with increasing Ni content. However, the change in formation probability with melting temperature is not a simple one as it is found that loops form more readily in pure nickel than in Cu-90%Ni. It was also found that the size of the dislocation loops varies markedly with alloy content. The higher the nickel content the smaller the loops. These results will be correlated with ion-beam mixing experiments to assess the role of vacancy mobility in the loop formation process. 21 refs., 4 figs., 1 tab.

32542 (CONF-900774–1) **Weldability of nickel aluminides.** Goodwin, G.M.; David, S.A. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From International Institute of Welding conference; Montreal (Canada); 23-24 Jul 1990. Order Number DE90008557. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The weldability of nickel aluminides, in terms of resistance to hot cracking, is evaluated based on testing of thin sheet using the Sigmajig hot cracking test and simulated repair welding of 2.5 x 2.5 x 7.5 cm ingots. The thin sheet tests showed that certain alloy compositions have cracking resistance within the range of commercial type 316 stainless steel. The ingot tests showed that only a few compositions could be welded without cracking. It is hypothesized that oxygen plays a role in the operative hot cracking mechanism. Rolled and welded tubing has been produced successfully from some of these materials.

32543 (DOE/PC/89904–T2, pp. 109-115) **Thermal methods for healing defects in protective oxide films on alloys.** Swisher, J.H.; Cho, W.D.; Qiu, W.W. Southern Illinois Univ., Carbondale, IL (USA). Coal Extraction and Utilization Research Center. Apr 1989. In *High-sulfur coal research at the SIUC Coal Technology Laboratory. Quarterly progress report, January 1-March 31, 1989.* Order Number DE89013667. Available from NTIS, PC A06/MF A01.

The work scope for the continuation of the project this year entails research on iron-chromium alloys, principally commercial

high-temperature alloys containing 2 to 9% chromium and 0.5% to 1% molybdenum. A literature review and general oxidation experiments completed this quarter show that these alloys are not very good in high-temperature oxidation resistance, and improvements could be of great value. The experimental conditions used were mildly oxidizing, which complements published data on oxidation in air and pure oxygen. One of the goals of these experiments was to identify a good set of conditions to use as a pretreatment step for defect healing studies. This goal was achieved with a temperature of 1150 C and a gas composition of $CO/CO_2 = 0.59$.

32544 (EGG-M-89160) **Metal matrix composites from dynamic consolidation of powder mixtures.** Korth, G.E.; Williamson, R.L.; Rabin, B.H. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 4p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-890812-67: American Physical Society topical conference on shock compression of condensed matter, Albuquerque, NM (USA), 14-17 Aug 1989). Order Number DE90010951. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Mixtures of 2124 aluminum alloy and silicon carbide powders were dynamically consolidated using explosives. This process results in a fully dense product and has the potential of becoming an economical method of producing metal matrix composites, especially where undesirable reactions would normally occur between the metal and ceramic reinforcement. With the correct processing parameters, the aluminum powder plastically deforms to form a continuous matrix with minimum interaction with SiC. Microstructure and mechanical properties of the composite are presented. Numerical simulations were performed to better understand the consolidation process and determine test parameters difficult to obtain by experimentation. 7 refs., 3 figs., 2 tabs.

32545 (FRCEA-TH-2317) **Development of a new fluorometric detection test of sulfatoreducing bacteria type Desulfovibrio. Laboratory evaluation of chemical control of bacteria activity in biocorrosion.** Kamecki-Duriez, L. CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France); Universite de Technologie de Compiegne, 60 (France). Jun 1989. 225p. (In French). Order Number DE90790592. Available from NTIS (US Sales Only), PC A10/MF A01.

Corrosion of metals is an important economical problem for petroleum industry. By hydrogenase activity (cathodic polarization) and sulfite reductase activity (sulfide production), sulfate-reducing bacteria (SRB) occur in anaerobic biocorrosion of metals. A specific bacterial enzyme of Desulfovibrio, the desulfoviridine is analyzed, in alkaline medium, by fluorescence emission. A relationship between enzyme concentration and fluorescence emission intensity at 610 nm is obtained with an excitation at 384 nm. Applied to five different species of Desulfovibrio fluorometry shows a detection limit of 5.10^3 to 10^4 SRB/ml without major interference from other biologic compounds. In few minutes 10^4 SRB are detected in oil production water. Five biocides are tested on SRB cultures. Good results are obtained with glutaraldehyde at 250 mg/l with a dispersing agent.

32546 (JAERI-M-89-206) **Filler metal development for hastelloy alloy XR.** Watanabe, Katsutoshi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Nakajima, Hajime; Sahira, Kensho; Kurauchi, Nobuyoshi; Takeiri, Toshiki; Saitoh, Teiichiro; Takatsu, Tamao; Nakanishi, Tsuneo. Japan Atomic Energy Research Inst., Tokyo (Japan). Dec 1989. 126p. (In Japanese). Order Number DE90791084. Available from NTIS (US Sales Only), PC A07/MF A01.

A method of alloy designing has been proposed and validated to develop the filler metal for Hastelloy alloy XR(nuclear reactor grade of Hastelloy alloy X), which is the candidate material for high temperature structure of High-Temperature Engineering Test Reactor (HTTR). In the filler metal development for Hastelloy alloy XR, materials of two heats were melted and fabricated with special emphasis placed on manufacturing process. One is the trial products (alloy termed 'C') designed by using multiple regression analysis in the range of the chemical composition specified as Hastelloy alloy X. The other is filler metal (alloy termed 'D') with optimum boron content in the same chemical composition as Hastelloy alloy XR. The results of the tests on several key items may be summarized as follows: (1) Weldments with alloy'C' showed higher strength and ductility at elevated temperatures than those of alloy'D'. (2) Weldments with alloy'D' had more excellent strength characteristics at elevated temperatures than those of the other conventional filler metals. (3) As for weldability, the crater cracks were slightly observed in the FISCO cracking test, but those were out of the problem in the degree of cracking from the viewpoint of practical application. The results of qualification tests on weldability showed good performance for all welding conditions of the present experiments. On the other hand, the mechanism of hot cracking initiation and the controlling factors in hot cracking susceptibility with relation to boron content have been clarified for Hastelloy alloy XR base metal. (author).

32547 (JAERI-M-90-013) **Experiments on tritium behavior in beryllium, (2): Tritium released by recoil and diffusion.** Ishitsuka, Etsuo (Japan Atomic Energy Research Inst., Oarai, Ibaraki (Japan). Oarai Research Establishment); Kawamura, Hiroshi; Nakata, Hirokatsu; Sugai, Hiroyuki; Tanase, Masakazu. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 41p. (In Japanese). Order Number DE90791151. Available from NTIS (US Sales Only), PC A03/MF A01.

Beryllium has been used as the neutron reflector of material testing reactor and as the neutron multiplier for the fusion reactor lately. To study the tritium behavior in beryllium, we conducted the experiments, i.e., tritium release by recoil or diffusion by using the hot-pressed beryllium which had been produced both tritium and helium by neutron irradiation. From our experiments, we found that (1) amount of tritium production per one cycle irradiation (lasting 22 days) of JMTR is 10 mCi/g, (2) amount of tritium per surface area of hot-pressed beryllium released by recoil is 4 $\mu Ci/cm^2$, (3) diffusion coefficient of tritium in a temperature range of 800 $\approx$1180degC can be expressed with the following equation; $D = 8.7 \times 10^4 \exp(-2.9 \times 10^5/R/T)$ cm^2/s. (author).

32548 (LA-11762-MS) **Encoding of the Burgess metal electrical resistivity model into SESAME format and its adaptation to the metal nickel.** Woodside, S.L.; Greene, A.E. Los Alamos National Lab., NM (USA). Mar 1990. 13p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. Order Number DE90010816. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An electrical resistivity model of metals, developed by Thomas J. Burgess, has been encoded into a computer program that calculates the resistivities as functions of temperature and density and provides the results in the format of the Los Alamos SESAME equation-of-state library. This model is rather heuristic. However, it is of interest because it concentrates on the low-temperature regimes and the solid to liquid to vapor transitions. These are areas that are not well handled by first principle theories. Burgess' publication provides input for six metals: aluminum, copper, gold, silver, stainless steel, and tungsten. We have extended the model to include the metal nickel. The purposes of this extension were to assist us in understanding the model in detail and to provide others with an approach for adapting the model to yet other metals. We have made the results of our calculations available on public files SESCU9. 12 refs., 7 figs., 2 tabs.

32549 (N-90-16686, pp. 24-57) **Study of metal corrosion using ac impedance techniques in the STS launch environment.** Calle, L.M. University of Central Florida, Orlando, FL (USA). Oct 1989. (NASA-CR-166837;NAS-1.26:166837;CONF-8906315-: NASA/ASEE summer faculty fellowship program conference, Merritt Island, FL (USA), 5 Jun 1989). In *NASA/ASEE Summer Faculty Fellowship Program.* Available from NTIS, PC A18/MF A03.

AC impedance measurements were performed to investigate the corrosion resistance of 19 alloys under conditions similar to the STS launch environment. The alloys were: Zirconium 702, Hastelloy C-22, Inconel 625, Hastelloy C-276, Hastelloy C-4, Inconel 600, 7Mo + N, Ferralium 255, Inco Alloy G-3, 20Cb-3, SS 904L, Inconel 825, SS 304LN, SS 316L, SS 317L, ES 2205, SS 304L, Hastelloy B-2, and Monel 400. AC impedance data were gathered for each alloy after one hour immersion time in each of the following three electrolyte solutions: 3.55 percent NaCl, 3.55 percent NaCl-0.1N HCl, and 3.55 percent NaCl-1.0N HCl. The data were analyzed qualitatively using the Nyquist plot and quantitatively using the Bode plot. Polarization resistance, Rp, values were obtained using

the Bode plot. Zirconium 702 was the most corrosion resistant alloy in the three electrolytes. The ordering of the other alloys according the their resistance to corrosion varied as the concentration of hydrochloric acid in the electrolyte increased. The corrosion resistance of Zirconium 702 and Ferralium 255 increased as the concentration of hydrochloric acid in the electrolyte increased. The corrosion resistance of the other 17 alloys decreased as the concentration of the hyrdochloric acid in the electrolyte increased.

32550 (NAGRA-NTB–89-19) **Experiments on container materials for Swiss high-level waste disposal projects. Part IV.** Simpson, J.P. (Sulzer Bros. Ltd., Winterthur (Switzerland)). Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Dec 1989. 47p. Available from Nagra, CH-5401 Baden, Switzerland.

One concept for final disposal of high-level waste in switzerland consists of a repository at a depth of 1000 to 1500 m in the crystalline bedrock of Northern Switzerland. The waste will be placed in a container which will be required to function as a high integrity barrier for at least 100 years. This report is the fourth and last in the current series dealing with the evaluation of potential materials for such containers. Four materials were identified for further evaluation in the first of these reports: cast steel, nodular cast iron, copper and Ti-Code 12. This report deals with the problem of demonstrating that cast steel containers will not fail by stress corrosion cracking and with the problem of hydrogen produced by the reduction of water. The experimental results on pre-cracked specimens revealed no susceptibility of cast steel to stress corrosion cracking under model repository conditions. No crack growth was detected on compact DCB specimens exposed in aerobic and anaerobic groundwaters at 80 and 140°C for 16-24 months. Cast steel remains a candidate material for high-level waste containers. As expected from thermodynamic considerations no hydrogen could be detected from copper immersed in model groundwaters at 50°C. Hydrogen is evolved from corroding steel under anaerobic conditions. Hydrogen evolution due to corrosion of iron or steel in waste repositories has to be considered in any safety analysis; the amounts produced can be significant. Evidence todate suggests that both cast steel and copper are suitable container materials. Because the corrosion behaviour of both materials is sensitive to service conditions, in particular length of the aerobic phase, groundwater chemistry and temperature, further testing should be undertaken when a specific site has been identified. (author) 9 tabs., 11 figs., 25 refs.

32551 (NUREG/CP–0104, pp. 2.7-2.8) **Power reactor embrittlement data base.** Kam, F.B.K. (Oak Ridge National Lab., TN (USA)); Stallmann, F.W.; Wang, J.A. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. DOE Contract AC05-84OR21400. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

Regulatory and research evaluations of embrittlement prediction models and of vessel integrity under load can be greatly expedited by the use of a well-designed computerized embrittlement data base. The Power Reactor Embrittlement Data Base (PR-EDB) is a comprehensive collection of data from surveillance reports and other published reports of commercial nuclear reactors. The uses of the data base require that as many different data as available are collected from as many sources as possible with complete references and that subsets of relevant data can be easily retrieved and processed. The objectives of this NRC-sponsored program are: (1) to compile and to verify the quality of the PR-EDB; (2) to provide user-friendly software to access and process the data; (3) to validate or confirm embrittlement prediction models; and (4) to interact with standards organizations to provide the technical bases for voluntary consensus standards that can be used in regulatory guides, standard review plans, and codes. To achieve these goals, the data base architecture was designed after much discussion and planning with prospective users, namely, materials scientists and members of the research staff.

32552 (NUREG/CP–0104, pp. 4.9-4.10) **Environmentally assisted cracking in light water reactors.** Shack, W.J. (Argonne National Lab., IL (USA)); Kassner, T.F.; Maiya, P.S.; Park, J.Y.; Ruther, W.E. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

Environmentally assisted degradation problems that have been considered during this year include (1) stress corrosion cracking (SCC) of austenitic stainless steels (SS), (2) fatigue of Type 316NG SS, and (3) SCC of ferritic steels used in reactor piping, pressure vessels, and steam generators. Fracture-mechanics crack-growth-rate tests on compact tension (1TCT) specimens of Types 304, 316NG, and 347 SS were performed to determine the effects of water chemistry on the SCC. Because operating reactors have made significant improvements in coolant purity over the past several years, recent attention has focused on quantifying the effects of low levels of organic impurities that are typically harder to detect and remove with conventional water cleanup systems. The tests show that some organic substances detected in reactor coolant systems at low concentrations actually inhibit SCC of sensitized Type 304 SS under simulated BWR water chemistries. Fatigue tests on Type 316NG SS were conducted in air and in a simulated BWR environment at frequencies of 0.5, 0.05, and 0.005 Hz. Baseline tests were performed in air under strain control during which the stroke histories were monitored. Comparison tests were then conducted under variable stroke control that simulated the stroke histories in the strain-control tests. This was not done on a cycle-by-cycle basis but instead, the average stroke amplitude over a range of cycles was matched (e.g., for cycles 0-100, 100-1,000, 1,000-10,000, etc.). The fatigue lives of the specimens under strain and stroke control were in excellent agreement. A similar procedure was used in tests performed in the simulated BWR environment. Even at a relatively high frequency of 0.5 Hz the fatigue lives in the environment were about one half of those in air, and the reduction in life increased as the frequency decreased.

32553 (ORNL/FTR–3606) **[Oxidation of intermetallics and ceramics]: Foreign trip report, March 23, 1990–April 12, 1990.** DeVan, J.H.; Tortorelli, P.F. Oak Ridge National Lab., TN (USA). 11 May 1990. 17p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. Order Number DE90011038. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The travelers presented papers at the Conference on Microscopy of Oxidation and learned about new applications of microscopic techniques to studies of oxides scales. Mr. DeVan visited the Corrosion and Protection Centre at UMIST to discuss oxidation of Fe_3Al. Dr. Tortorelli visited Cranfield Institute of Technology to discuss the mechanical properties of oxide scales. Both travelers visited the Coal Research Establishment of British Coal to review results from exposure of Fe_3Al in a gasifier environment and plans for development of advanced coal-fired power generation utilizing a topping cycle. The ORNL staff members independently visited Harwell Laboratory to present results on oxidation of Ni_3Al composites, discuss indentation testing of oxide scales, and help conduct a secondary ion mass spectrometry (SIMS) investigation of oxidized Ni_3Al–Al_2O_3. Harwell was underground a change from a national laboratory to a profit-based business venture.

32554 (ORNL/FTR–3609) **[Neutron scattering studies of spatial correlations in Fe-V and Fe-Cr alloys]: Foreign trip report, September 30, 1989–April 23, 1990.** Cable, J.W. Oak Ridge National Lab., TN (USA). 8 May 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90011040. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler was on a foreign research assignment at the Laboratoire Leon Brillouin, Saclay, France, from October 1, 1989, to April 23, 1990. The research activities pursued during this assignment involved neutron scattering studies of the atomic and magnetic spatial correlations in Fe–V and Fe–Cr alloys. Major results and conclusions are summarized in this report.

32555 (PB–90-863341/XAB) **Corrosion prevention: Conversion coatings and coating processes. July 1971-January 1990 (A Bibliography from the US Patent data base). Report for July**

1971-January 1990. National Technical Information Service, Springfield, VA (USA). Mar 1990. 57p. Available from NTISPC N01/MF N01.

Supersedes PB-88-867288.

This bibliography contains citations of selected patents concerning conversion coatings and coating processes for the prevention and elimination of metal corrosion in various environments. Conversion coating patents for the application of phosphates and chromates to the surfaces of aluminum, zinc, ferrous metals, titanium, cadmium, iron, steels, and various alloys are presented. Topics include coating compositions, surface preparations and pretreatments prior to coating applications, post-treatment of coated metal surfaces, coating quality control, and sacrificial coatings for jet engines. Specific patents concerning protective coatings are excluded and covered in a separate bibliography. (This updated bibliography contains 131 citations, 25 of which are new entries to the previous edition.)

32556 (PB-90-864133/XAB) **Anticorrosive pigments. January 1980-December 1989 (A Bibliography from World Surface Coatings Abstracts). Report for January 1980-December 1989.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 87p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the composition and preparation of pigments that have good anticorrosion and weather-resistant qualities. Included are non-lead pigments to replace lead-based pigments, and reports of tests on pigments and the anticorrosive properties. There are some references to resin compositions developed specifically for use with these pigments. (Contains 194 citations fully indexed and including a title list.)

32557 (SAND-90-0341C) **An examination of the 1-MeV equivalent silicon damage methodology.** Griffin, P.J. (Sandia National Labs., Albuquerque, NM (USA)); Kelly, J.G.; Luera, T.F.; Lazo, M.S. Sandia National Labs., Albuquerque, NM (USA). [1990]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900723-4: 27. IEEE annual international nuclear and space radiation effects conference, Reno, NV (USA), 16-20 Jul 1990). Order Number DE90007167. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The assumptions, approximations, and uncertainty in the 1-MeV equivalent silicon damage methodology are reviewed. A new silicon displacement kerma function, based on ENDF/B-VI cross sections, is presented and its shape is experimentally confirmed. The issue of an associated 1-MeV equivalent reference kerma value is discussed. 19 refs., 4 figs.

32558 (UCRL-101690) **Ambient-temperature creep failure of silver-aided diffusion bonds between steel.** Henshall, G.A.; Kassner, M.E.; Rosen, R.S. Lawrence Livermore National Lab., CA (USA). 15 Jan 1990. 21p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9003155-1: 2. international conference on diffusion bonding-applications, Cranfield (UK), 28-29 Mar 1990). Order Number DE90010687. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

It has long been known that thin (e.g., 1 μm – 1 mm) interlayer bonds between higher strength base materials may have high ultimate tensile or rupture strengths despite the relatively low strength of the filler metal. The high strength of the joint is due to the mechanical constraint provided by the stronger base metals which restricts transverse contraction of the interlayer. The constraint produces a triaxial state or stress and reduces the effective stress, thus reducing the tendency for the interlayer to plastically deform. Plasticity of the base metal reduces the constraint and decreases the strength of the bond. The purpose of this work was twofold. First, the validity of the "base-metal- accelerated" delayed-failure theory for bonds utilizing plastic base metals was checked. Creep-rupture tests were performed on diffusion-bonded specimens using silver interlayers deposited by planar-magnetron sputtering (PMS), a physical vapor-deposition process. The PMS process was preferred because of the superior quality and strength of the bond and because this modern low-temperature joining process is increasingly utilized for joining ceramic and composite materials. The role of plastic base metals in the fracture process was further investigated by conducting tensile-rupture tests of diffusion bonds made with stainless steel base metals of different yield strengths, and therefore different creep rates. The second purpose was to determine whether delayed failure occurs in interlayer bonds between elastic base metals, which do not creep over the range of applied stresses. This question is particularly relevant since many alloys, ceramics and composites fall within this category. Again, ambient and near-ambient temperature creep-rupture tests were performed at a variety of stresses below the UTS of the bond. 25 refs., 7 figs.

32559 **Mechanical properties of nanometre volumes of material: Use of the elastic response of small area indentations.** Pethica, J.B. (Dept. of Metallurgy and Science of Materials, Parks Road, Oxford OX1 3PH (GB)); Coliver, W. 13-24 of Thin films: Stresses and mechanical properties. Bravman, J.C.; Nix, W.D.; Barnett, D.M.; Smith, D.A. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811222-: Thin films: stresses and mechanical properties, Boston, MA (USA), 28-30 Nov 1988).

A new, differential method for determining the stiffness of a submicronindentation contact area is presented. This allows measurement of elastic modulus as well as plastic hardness, continuously during a single indentation, and without the need for discrete unloading cycles. Some of the new experiments that become possible with this technique, especially at the nanometre scale, are described. The authors show quantitatively that electropolished tungsten reproducibly exhibits the ideal theoretical lattice strength at small indentation loads.

32560 **Effect of aluminum level on boron clustering in Ni_3Al.** Horton, J.A. (Metals and Ceramics Div., Oak Ridge National Lab., Oak Ridge, TN (US)); Miller, M.K.; Liu, C.T.; George, E.P.; Bentley, J. 89-98 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-8811161-: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

In alloys containing 0.24% boron, atom-probe field-ion microscopy (APFIM) revealed the presence of boron clusters in Ni-25 at % Al and Ni-26 Al but not in Ni-24 Al. The observed boron clusters generally consisted of two to three boron atoms with a maximum size of 10 atoms. Quench rates that ranged from rapid solidification to furnace cooling has little effect on the clustering. The occurrence of the clustering coincides with a higher rate of boron strengthening as measured by an increase in the yield stress per atomic percent boron, and it also coincides with a reduced amount of boron segregation to grain boundaries. The levels of nickel and boron were highly variable on grain boundaries in rapidly solidified material and therefore no consistent indication of nickel enrichment at the grain boundaries associated with boron segregation was found. This result suggests that cosegregation of nickel with boron may not be necessary for the ductilization of Ni_3Al by boron, since the rapidly solidified material is also ductilized by boron and exhibits segregation of only boron to the grain boundaries.

32561 **Stacking fault energies, crystal elasticity and their relation to the mechanical properties of $L1_2$-ordered alloys.** Fu, C.L. (Metals and Ceramics Div., Oak Ridge National Lab., Oak Ridge, TN (US)); Yoo, M.H. 81-88 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-8811161-: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

First-principles calculations of the stacking fault energies of Ni_3Al, and the linear elastic constants of Ni_3Al and Pt_3Al are presented. The anomalous (positive) temperature dependence of flow stress in Ni_3Al and its absence in Pt_3Al are fully rationalized in terms of the present results and cross-slip pinning mechanism. It is found that the elastic shear anisotropy factor plays an equally (or even more) important role than the anisotropy of antiphase-phase boundary energy in determining in plastic flow behavior of $L1_2$- ordered alloys.

32562 **Structure maps and phase stability in $AlTi_3$ alloyed with rare-earth elements.** Liu, C.T. (Metals and Ceramics Div., Oak Ridge National Lab., Oak Ridge, TN (US)); Horton, J.A.; Pettifor, D.G. 37-44 of High-temperature ordered intermetallic alloys III.

Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

Rare-earth elements including Y, Er and Sc were added to $AlTi_3$ for stabilizing the $L1_2$ ordered crystal structure, as predicted by the AB_3 structure map. The crystal structure and phase composition in the $AlTi_3$ alloys were studied by electron microprobe analysis, X-ray diffraction and TEM. The solubility limit of the rare-earth elements were determined and correlated with the atomic size factor. The results obtained so far indicate that rare-earth additions are unable to change the crystal structure of $AlTi_3$ from DO_{19} to $L1_2$. The inability to stabilize the $L1_2$ structure demonstrates the need to characterize the structure map domains with a further period-dependent parameter.

32563 Some thermodynamic propeties of NiAl calculated by molecular dynamics simulations. Clapp, P.C. (Institute of Materials Science, Univ. of Connecticut, Storrs, CT (US)); Rubins, M.J.; Charpenay, S.; Rifkin, J.A.; Yu, Z.Z.; Voter, A.F. 29-36 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). Contract 33615-86-C-5037. (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

Calculations of the surface free energy and anti-phase boundary energy as a function of low index orientations and temperature have been determined for equiatomic perfectly ordered bcc NiAl via molecular dynamics computer simulations. The simulations utilized an embedded atom method calculation of the interatomic potentials and volume forces in the Ni-Al alloy system. Values of about 0.95, 1.6, 1.9 and 2.0 J/m^2 were found for surface energies of the (100), (110), (112) and (111) orientations, respectively. APB energies of about 0.24 and 0.38 J/m^2 were determined for (110) and (112) boundaries, respectively. In addition, the authors examine the phase stability and relative energies of the ordered bcc, fcc and bct phases at low temperature, and find a bct phase with $c/a \simeq 1.32$ slightly lower in energy than the bcc, presaging the martensitic transformation that occurs at finite temperatures in more nickel rich alloys.

32564 Structural energy differences in Al_3Ti: The role of tetragonal distortion in APB and twin energies. Nicholson, D.M. (Oak Ridge National Lab., TN (US)); Stocks, G.M.; Temmerman, W.M.; Sterne, P.; Pettifor, D.G. 17-22 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

At stoichiometry, $D0_{22}$ is the observed ground state of Al_3Ti and has a C/A ratio of 2.23, but as a function of both concentration and temperature other ordered arrangements of APB's are observed. These phase transitions have sparked many studies in which the energy has been treated as that of chemical rearrangement on an fcc lattice. The authors have found that at the ideal C/A ratio, the $L1_2$ structure is lower in energy, but as the tetragonal distortion increases the $D0_{22}$ energy drops below that of $L1_2$. The critical role played by the tetragonal in the balance between $L1_2$ and $D0_{22}$ energies precludes the use of any model based on the undistorted lattice. The major impediment to the development of Al_3Ti as a high-temperature material is its lack of ductility. The standard approach is to make alloy additions which transform the structure to $L1_2$. An alternate approach is to work toward the enhancement of ductility in the $D0_{22}$ phase. As a first step the authors calculate the twinning energy in Al_3Ti.

32565 Critical phenomena in nanoscale multilayer materials. Tsakalakos, T. (Dept. of Mechanics and Material Science, Rutgers Univ., Piscataway, N.J. (US)); Jankowski, A. 199-212 of Multicomponent ultrafine microstructures. McCandlish, L.E.; Kear, B.H.; Polk, D.E.; Siegel, R.W. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-8811279–: Multicomponent ultrafine microstructures, Boston, MA (USA), 30 Nov - 1 dec 1988).

The authors present a review of critical phenomena in a variety of nanoscale multilayer materials. Discontinuities of interdiffusitives at low temperatures, the Supermodulus effect and the softening of elastic constants of fcc-bcc structures, other mechanical properties at critical layer thickness are also presented. Some new calculations of elastic constants of (111) fcc and (110) bcc metallic superlattices show large changes as a function of homogeneous lattice strains. The effect of structural relaxations on a number of electronic and magnetic properties is discussed and a new analytical model is developed to explain the origin of interference effects when interfaces are apart by a few interplanar spacings. This model can predict relaxations at interfaces for a variety of materials including metals, semiconductors and ceramics.

32566 Mechanism of achieving nanocrystalline AlRu by ball milling. Hellstern, E. (W.M. Keck Lab., of Engineering Materials, California Institute of Technology, Pasadena, CA (US)); Fecht, H.J.; Garland, C.; Johnson, W.L. 137-142 of Multicomponent ultrafine microstructures. McCandlish, L.E.; Kear, B.H.; Polk, D.E.; Siegel, R.W. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811279–: Multicomponent ultrafine microstructures, Boston, MA (USA), 30 Nov - 1 dec 1988).

The authors have investigated through x-ray diffraction and transmission electron microcopy the crystal refinement of the intermetallic compound AlRu by high-energy ball milling. The deformation process causes a decrease of crystal size to 5–7 nm and an increase of atomic level strain. This deformation is localized in shear bands with a thickness of 0.5 to 1 micron. Within these bands the crystal lattice breaks into small grains with a typical size of 8–14 nm. Further deformation leads to a final nanocrystalline structure with randomly oriented crystalline grains separated by high-angle grain boundaries.

32567 Surface energy anisotropy of diffusion-induced Ni_3Al crystals. Chou, T.C. (Research and Development, Engelhard Corp., Edison, NJ (US)); Chou, Y.T. 161-166 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

This paper reports on faceted crystals with well-defined 100, 110, and 111 surfaces observed in the interdiffusion zone during chemical interdiffusion of Ni/Ni_3Al diffusion couple in the temperature range of 800°C - 1200°C. Composition of the diffusion-induced crystals was determined to be 87.6Ni–12.4Al (wt%) by electron microprobe. The shape of Ni_3Alcrystals showed a 26-sided polyhedron (rhombicuboctahedron) with a m3m point group symmetry at low temperature range (800° to 1000°C). At high temperatures, for example at 1212°C, the crystal shape changes to a 14-sided polyhedral form (tetrakaidecahedron) with the same point group symmetry. Based on the crystal geometry, equations describing the surface energy anisotropy, $\gamma 111/\gamma 100$, and $\gamma 110/\gamma 100$, were obtained. The surface-energy anisotropy was then calculated from the crystal dimension. For the equilibrium crystals with tetrakaidecahedral form, the inequailty $\gamma 100 > \gamma 100 > \gamma 111$ holds.

32568 Ion-beam mixing in amorphous and crystalline Fe-Ti. Scheuer, U. (Materials Science Div., Argonne National Lab., Argonne, IL (US)); Rehn, L.E.; Baldo, P. 213-218 of Processing and characterization of materials using ion beams. Rehn, L.E.; Greene, J.; Smidt, F.A. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-31109-ENG-38. (CONF-8811225–: Processing and characterization of materials using ion beams, Boston, MA (USA), 28 Nov - 2 dec 1988).

Crystalline Fe and Fe-10at.%Ti and amorphous Fe-37at.%Ti films with Ag and Hf markers were produced by vapor deposition. Marker spreading during ion- beam mixing between 77 K and 580 K was measured using Rutherford Backscattering (RBS). Marker spreading was also measured between temperatures of 300 K to 700 K after full crystallization of the Fe-37at.%Ti films. Microstructural changes during ion-beam mixing were studied in situ, in a high-voltage electron microscope. Homogeneous nucleation of a metastable bcc phase was observed at high temperatures. The results are discussed in terms of their relevance to radiation-enhanced diffusion in amorphous materials.

32569 Amorphous and metastable phase formation in systems with positive heats of mixing using high-rate sputter deposition. Rizzo, H.F. (Lawrence Livermore National Lab., CA (USA). A Div.); Echeverria, A.; Massalski, T.B.; Baxi, A.H. 231-236 of Processing and characterization of materials using ion beams. Rehn, L.E.; Greene, J.; Smidt, F.A. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-8811225–: Processing and characterization of materials using ion beams, Boston, MA (USA), 28 Nov - 2 dec 1988).

The triode sputtering technique and a split-target arrangement were used to produce metastable crystalline and amorphous phases in the Cu-W, Mo-Cu, Ag-Fe, Ag-Cu, Pu-Ta and Pu-V systems. These systems all exhibit liquid and solid immiscibility and have positive heats of mixing and atomic radii that differ by at least 10%. The sputtered coatings, whose thickness varied between 25 and 200 microns, were formed at deposition rates between 35 and 200 Å/s. They were characterized using x-ray diffraction, TEM, microprobe, microhardness, and DSC techniques. The observed amorphous and metastable solid solution phases are discussed in terms of predicated heats of formation for these phases using Miedema's thermodynamic approximations that include chemical, elastic, and structural contributions. Differences in compositional ranges observed by high rate sputter deposition compared to other vapor deposition techniques (e.g., coevaporation) appeared to arise as a result of processes that occur during deposition or immediately following deposition.

32570 X-ray diffraction analysis of Au/Ni multilayers. Chaudhuri, J. (The Wichita State Univ., Wichita, KS (US)); Shah, S.; Jankowski, A.F. 231-237 of Multicomponent ultrafine microstructures. McCandlish, L.E.; Kear, B.H.; Polk, D.E.; Siegel, R.W. Materials Research Society, Pittsburgh, PA (USA) (1989). Grant DMR-8605564. (CONF-8811279–: Multicomponent ultrafine microstructures, Boston, MA (USA), 30 Nov - 1 dec 1988).

X-ray diffraction is a useful method to measure the microscopic strain profile in multilayered materials. Depth profiles of strain in the modulation direction are obtained by an iterative fitting of the experimental diffraction pattern with a kinematic model. This paper reports this approach used to characterize the coherency strain profile in Au/Ni superlattices. The accommodation of coherency strain through the superlattice is dependent upon the atomic misfit between the component materials and the thickness of each layer. The depth profile of strain was determined for multilayers with repeat periodicities of 2.92 nm and 4.26 nm. A significant volume fraction of interfaces is present in these nanometric dimensioned laminates.

32571 Effect of preoxidation and grain size in ductility of a boron-doped Ni_3Al at elevated temperatures. Takeyama, M. (Metals and Ceramics Div., Oak Ridge National Lab, Oak Ridge, TN (US)); Liu, C.T. 293-298 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

This paper reports the ductility of preoxidized Ni_3Al (Ni-23Al-0.5Hf-0.2B, at.%) specimens with various grain sized ($17 \approx 193 \mu m$) evaluated by means of tensile tests at 600 and 760°C in vacuum. It was found that the preoxidation does not affect the ductility of the finest-grained material at either temperature, whereas it causes severe embrittlement in the larget-grained material, expecially at 760°C. A continuous, thin Al-rich oxide layer, which forms on the fine-grained samples, protects the underlying alloy from oxygen penetration, peventing any loss of ductility, whereas the nickel-rich oxide which forms on the large-grained samples allows oxygen to penetrate along grain boundaries, causing severe embrittlement. The grain boundaries act as short-circuit paths for rapid duffusion of aluminum atoms from the bulk to the surfaces, and this is responsible for the difference in oxidation behavior between fine- and large-grained materials. The embrittlement of large-grained samples can be eliminated through control of oxide formation on Ni_3Al surfaces.

32572 Internal hydriding in irradiated defected Zircaloy fuel rods. Clayton, J.C. (Westinghouse Electric Corp., West Mifflin, PA (USA). Bettis Atomic Power Lab.). 266-290 of Proceedings of the ASTM 8th international symposium zirconium in the nuclear industry. Van Swam, L.F.P.; Eucken, C.M. ASTM, Philadelphia, PA (USA) (1989). (CONF-880696–: 8. international symposium on zirconium in the nuclear industry, San Diego, CA (USA), 19-23 Jun 1988).

Internal hydriding of Zircaloy cladding is a persistent cause of cladding failures. It occurs in the fuel rods of water-cooled nuclear power reactors that have a small cladding defect. This report summarizes the experimental findings, causes, and mechanisms of internal hydriding in defected Zircaloy-clad fuel rods. Irradiation test data on the different types of defected fuel rods, intentionally fabricated defected and in-pile operationally defected rods, are compared. Significant factors affecting internal hydriding in defected Zircaloy-clad fuel rods (defect hole size, internal and external sources of hydrogen, Zircaloy cladding surface properties, nickel alloy contamination of Zircaloy, the effect of heat flux, and fluence) are discussed. Pertinent in-pile and out-of-pile test results are used as a data base in constructing a qualitative model that explains hydrogen generation and distribution in Zircaloy cladding of defected water-cooled reactor fuel rods.

32573 Tribology of amorphous alloys formed with ion beams. Follstaedt, D.M. (Sandia National Lab., Albuquerque, NM (US)); Knapp, J.A.; Pope, L.E. 389-402 of Processing and characterization of materials using ion beams. Rehn, L.E.; Greene, J.; Smidt, F.A. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811225–: Processing and characterization of materials using ion beams, Boston, MA (USA), 28 Nov - 2 dec 1988).

The changes in friction and wear properties (i.e., tribology) of steels due to thin surface alloys formed by ion beams are surveyed, and considered in light of their microstructures. Amorphous alloys containing both Ti and C are found to give superior performance in comparison to alloys with N, B, C, P or Ti. All the amorphous layers reduce friction, but the duration of benefits and wear resistance at high loads vary with composition. By examining similar amorphous alloys with Ti alone or C alone, the critical roles played by each in resisting wear are demonstrated. Amorphous alloys with Ti and C appear to be quite hard.

32574 Amorphization of Zr_3Al by hydrogenation and subsequent electron irradiation. Meng, W.J. (Materials Science Div., Argonne National Lab., Argonne, IL (US)); Koike, J.; Okamoto, P.R.; Rehn, L.E. 345-350 of Processing and characterization of materials using ion beams. Rehn, L.E.; Greene, J.; Smidt, F.A. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811225–: Processing and characterization of materials using ion beams, Boston, MA (USA), 28 Nov - 2 dec 1988).

1-MeV electron irradiation of hydrogenated Zr_3Al ($Zr_3AlH_{0.96}$) at 10K is studied. A more than 20 fold reduction in the critical dose required for complete amorphization is observed for the hydrogenated specimen as compared to the un-hydrogenated Zr_3Al under identical irradiation conditions.

32575 The effect of simultaneous electron and Kr^+ irradiation on amorphization of CuTi. Koike, J. (Argonne National Lab., IL (USA). Materials Science and Technology Div.); Okamoto, P.R.; Rehn, L.E.; Meshii, M. 339-344 of Processing and characterization of materials using ion beams. Rehn, L.E.; Greene, J.; Smidt, F.A. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-31-109-ENG-38. Grant DMR-8411178. (CONF-8811225–: Processing and characterization of materials using ion beams, Boston, MA (USA), 28 Nov - 2 dec 1988).

CuTi was irradiated with 1-MeV electrons and Kr^+ ions simultaneously at temperatures from 10 to 423 K. Retardation of Kr^+-induced amorphization was observed with simultaneous electron irradiation at 295 and 423 K. The retardation effect increased with increasing irradiation temperature and relative electron-to-Kr dose rate. In contrast, simultaneous irradiation below 100 K showed an additive effect of electron- and Kr^+-induced amorphization. The results are explained by the mobility point defects introduced by electron irradiation interacting with Kr^+-induced displacement cascades.

32576 Microstructure and mechanical properties of Ll_2-structure alloys based on Al_3Zr. Schneibel, J.H. (Metals and Ceramics Div., Oak Ridge National Lab., Oak Ridge, TN (US));

Porter, W.D. 335-340 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

The tetragonal compound Al_3Zr can be transformed into the cubic $L1_2$ structure by additions of Cr, Fe, Ni or Cu. This result is interpreted in terms of Pettifor's structure map. The transformation is accompanied by substantial softening. The significant porosity of cast buttons which develops during the homogenization required to produce the $L1_2$ structure is attributed to the Kirkendall effect. Al-5.5Fe-25Zr (at.%) specimens with the $L1_2$ structure can be deformed at room temperature in compression, and their yield stress has been determined as a function of temperature. Al-Fe-Zr is nevertheless a brittle material. This is illustrated for a Al-Fe-V-Zr $L1_2$-structure compound, the fracture toughness of which is only slightly higher than that of sintered SiC. Evidence is presented to suggest that $L1_2$ formation is accompanied by an increase in toughness. Significant improvements in the mechanical properties of Al_3Zr-type alloys may possibly be achieved by improved processing.

32577 Identification of cleavage planes in the Al_3Ti-base alloy by electron channeling in the SEM. George, E.P. (Metals and Ceramics Div., Oak Ridge National Lab, Oak Ridge, TN (US)); Porter, W.D.; Joy, D.C. 311-316 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

This paper reports selected area electron channeling patterns used to identify the cleavage planes in a polycrystalline Al_3 Ti-base alloy having the $L1_2$ structure. In order to do this unambiguously in the scanning electron microscope (SEM), one needs to know that the cleavage facet from which any given channeling pattern is obtained is indeed normal to the electron beam. The authors accomplished this by utilizing a recently-developed technique in which an optical microscope with a short depth of focus is inserted in the SEM column and used to measure the elevations of several points on the cleavage facets. By appropriately tilting and rotating the sample, and using the optical microscope to measure elevations, it was possible to orient the facets normal to the beam. The cleavage planes in a cast and extruded alloy having an equiaxed grain structure were compared with those in a directionally-solidified (DS) alloy of the same composition. Of the eight cleavage facets examined in the DS material, six were of the 110 type and two were of the 111 type. Of the six facets examined in the cast and extruded material, two each were of the 110 and 111 types, and one each were of the 100 and 013 types. Although it cannot be the that all possible cleavage planes have been identified in this alloy, the availability of several low-strength cleavage planes apparently exacerbates its brittleness.

32578 The development of alloys based on Ni_3Si. Oliver, W.C. (Metals and Ceramics Div., Oak Ridge National Lab., Oak Ridge, TN (US)). 397-402 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

Alloys with large volume fractions of the intermetallic phase Ni_3Si have unique aqueous corrosion resistance that provides the driving force for an alloy design program to improve their generally poor room temperature mechanical properties. The target of the alloy design program at Oak Ridge National Laboratory was to produce wrought alloys with at least 10% room temperature ductility while retaining good aqueous corrosion resistance. In this paper, findings are discussed. These include macro and micro alloying (B, C, Be) to produce superplastic wrought alloys with high strength and high room-temperature ductility. Some of the alloys developed are strong enough to be competitive with medium temperature structural alloys such as Inconel 718.

32579 High resolution electron microscopy study of as-prepared and annealed tungsten-carbon multilayers. Nguyen, T.D. (Center for X-ray Optics, Accelerator and Fusion Research Div (US)); Kortright, J.B.; Gronsky, R. 357-362 of High resolution microscopy of materials. Krakow, W.; Ponce, F.A.; Smith, D.J. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC03-76SF00098. Grant F49620-87-K-0001. (CONF-8811196–: MRS symposium on high resolution microscopy of materials, Boston, MA (USA), 29 Nov - 1 dec 1988).

A series of sputtered tungsten-carbon multilayer structures with periods ranging from 2 to 12 nm in the as-prepared state and after annealing at 500°C for 4 hours has been studied with high resolution transmission electron microscopy. The evolution with annealing of the microstructure of these multilayers depends on their period.As-prepared structures appear predominantly amorphous from TEM imaging and diffraction. Annealing results in crystallization of the W-rich layers into WC in the larger period samples, and less complete or no crystallization in the smaller period samples. X-ray scattering reveals that annealing expands the period in a systematic way. The layers remain remarkably well-defined after annealing under these conditions.

32580 Phase stability of Ni_3Al_3 under electron irradiation. Kenik, E.A. (Oak Ridge National Lab., TN (USA). Metals and Ceramics Div.); Nastasi, M. 333-338 of Processing and characterization of materials using ion beams. Rehn, L.E.; Greene, J.; Smidt, F.A. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-8811225–: Processing and characterization of materials using ion beams, Boston, MA (USA), 28 Nov - 2 dec 1988).

In-situ electron irradiations at 200, 300, and 1000 keV have been performed on Ni_2Al_3 at 100 and 300 K. At low doses, the Ni_2Al_3 partially disorders to a B2 structure with a lattice parameter of 0.284 nm, close to that extrapolated for β-NiAl at 60 at.% Al, the Ni_2Al_3 composition. The electron dose required to disorder the Ni_2Al_3 decreased with increasing accelerating voltage and possibly with decreasing temperature. At high doses, precipitation of aluminum from the B2 matrix occurs, along with radiation-induced sputtering and radiation-induced segregation. Lattice parameter changes for the B2 structure observed during irradiation are explained in terms of the compositional dependence of the lattice parameter of β-NiAl. The B2 structure remains stable to a dose of 6×10^{28} electrons/m^2, with no amorphization detected.

32581 The low-temperature phase diagram of $U_{2-x}Th_xBe_{13}$. Felder, E. (Los Alamos National Lab., NM (USA)); Bernasconi, A.; Ott, H.R.; Fisk, Z.; Smith, J.S. 429-430 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Measurements of specific heat c_p (T) and thermal conductivity λ (T) give a detailed picture of the T_c (x) phase diagram of superconducting U_{1-x} Th $_x$ Be $_{13}$ below 1 K. A distinct minimum for T_c is noted for $x \sim 0.018$. Increasing x further results in increasing values for T_{c1} and the occurrence of a second phase transition in the superconducting state at $T_{c2} < T_{c1}$. Two phase transitions are observed between $0.02 < x < 0.045$. T_{c2} is toughly constant with varying x. For $x > 0.05$, only one single transition occurs and T_c decreases with further increasing x. Anomalous behavior is also observed for UBe_{13-y} By for y values between 0 and 0.05 in the sense that the c_p anomalies at the superconducting transition are distinctly larger than the corresponding discontinuity observed in pure UBe_{13}. The influence of B-doping on the phase diagram of U_{1-x} Th $_x$ Be $_{13}$ has also been studied.

32582 Reinforcement/matrix interaction in SiC fiber-reinforced Ni_3Al matrix composites. Yang, J.M. (Dept. of Materials Science and Engineering, Univ. of California, Los Angeles, CA (US)); Kao, W.H.; Liu, C.T,. 453-458 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-8811161–: 3.

MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

This paper presents an investigation of the interfacial reaction characteristics of two different types of SiC fibers with Ni_3Al (Ni-Al-Cr-Zr-B) matrix. The microstructure and chemical compositions across the reaction zone have been analyzed quantitatively using microscopy and electron probe microanalysis. In both types of SiC/Ni_3Al composites, it was found that Ni was the dominant diffusing species responsible for the overall reaction. The C-rich layer outside the SCS-6 fiber provided an incubation period, but could not stop the inward diffusion of Ni. It could, however, effectively stop the diffusion of Al,Zr and Cr. No significant increase in reaction zone thickness after exposure at temperatures below 900 ° C for up to 100 hours was observed. When the C-rich layer was depleted, a rapid increase in reaction zone thickness and the formation of multilayer reaction products occurred. In the case of Sigma/Ni_3Al composite, extensive reaction between the fiber and the matrix occurred at all the temperatures studied. Diffusion barrier coating for both types of fibers is required to develop nickel aluminide matrix composites.

32583 **Beta-quenched Zircaloy-4: Effects of thermal aging and neutron irradiation.** Yang, W.J.S. (Knolls Atomic Power Lab., Schenectady, NY (USA)); Adamson, R.B. 451-477 of Proceedings of the ASTM 8th international symposium zirconium in the nuclear industry. Van Swam, L.F.P.; Eucken, C.M. ASTM, Philadelphia, PA (USA) (1989). (CONF-880696–: 8. international symposium on zirconium in the nuclear industry, San Diego, CA (USA), 19-23 Jun 1988).

This paper reports Zircaloy-4, a zirconium base alloy used extensively as cladding and core-structural materials in water-cooled nuclear reactors, examined by transmission electron microscopy (TEM) after quench-and-aging treatments, neutron irradiation, and postirradiation annealing. Phase instabilities found after quench-and-aging treatments include: formation of the metastable precipitate $Zr_4(Fe,Cr)$ during quench from the β-phase field and dissolution of metastable $Zr_4(Fe,Cr)$ and formation of the stable precipitate $Zr(Fe,Cr)_2$ during aging in the α-phase field after quench. Rapid precipitation of $Zr(Fe,Cr)_2$ occurs on aging at 750°C. The initial crystallographic structure of the precipitate is cubic, but the hexagonal structure predominates after aging. Microhardness reflects the microstructural changes that occur during annealing, but nodular corrosion resistance remains excellent throughout, except at the extremes of annealing temperature and time.

32584 **Hydrogen ion beam smoothening of oxygen roughened η(001) surfaces.** Horn, K.M. (Sandia National Lab, Albuquerque, NM (US)); Chason, E.; Tsao, J.Y.; Picraux, S.T. 549-554 of Chemical perspectives of microelectronic materials. Gross, M.E.; Jasinski, J.M.; Yates, J.T. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC04-76DP00789. (CONF-8811223–: Chemical perspectives of microelectronic materials, Boston, MA (USA), 30 Nov - 2 dec 1988).

The authors discuss how a smooth Ge(001) surface can be severely roughened by chemical etching with oxygen gas and then returned to its original smoothness by exposure to hydrogen. The rate of recovery of the surface depends strongly on temperature, as well as on whether the hydrogen is introduced as a low energy ion beam or simply as a gas. The roughness induced in the surface by etching is locked-in after removal of the oxygen gas through pinning of ledges by residual contamination. This pinning prevents the surface from smoothening thermally. The introduction of hydrogen to the surface promotes a chemical reaction which frees the pinned sites and allows thermal smoothening to proceed.

32585 **Phase and microstructure of Fe modified Al_3Ti.** Porter, W.D. (Metals and Ceramics Div., Oak Ridge National Lab, Oak Ridge, TN (US)); Sparks, C.J.; Oliver, W.C.; Hisatsune, K.; Dhere, A. 657-662 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

This paper reports alloys of $al_{75-x}Fe_xTi_{25}$, where x = 0 to 12 at.% Fe, fabricated by splat cooling and examined primarily with X-ray diffraction to determine the crystallographic phases present, their composition, volume fraction, lattice parameters, and sublattice occupation. The tetragonal DO_{22} structure of Al_3Ti disolved 0.8 + 0.4 at %Fe, with additional iron partioned to the Ll_2 structure containing 6.2 + 0.4 at.% Fe, and completed the transformation to the Li_2 structue with the addition of about 6 at.% Fe. The lattice parameters of both phases were independent of iron concentration up to about 6 at.%. At 8 at.% Fe, the iron was found to be predominatly distributed on the nominal alumium sublattice which also contained abut 5 at.% Ti. The Al_3Ti composition was similarly found to contain about 5 at.% Ti on the aluminum sublattice. All compositions, including a single crystal of $Al_{67}Fe_8Ti_{25}$, were found to be brittle.

32586 **Annealing studies of B2FeAl.** Schmidt, B. (Thayer School of Engineering, Dartmouth College, Hanover, NH (US)); Nagpal, P.; Baker, I. 755-760 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

This paper discusses a study of rods of five FeAl alloys, whose compositons span the B2 phase field (34-51 at. % Al), produced by multipule hot extrusions of ingots. Samples of each alloy were annealed in air at 1173K and 1473K in order to study the effect of alloy composition on both the grain growth kinetics and on the rate of oxidation. Little oxidation occurred at 1173K but at 1473K the oxidation rate was found to decrease with increasing aluminum concentration. The predominant oxide was found to be $\alpha-Al_2O_3$. The grain size was found to increase rapidly during the first hour of annealing at both temperatures after which it icreased more slowly. The grain growth rate was found to decrease with increasing aluminum content. Hardness measurements were made on both as-extruded and annealed samples of FeAl. Hardness increased with the increasing aluminum content. The hardness was higher in annealed samples also showed higher yield strengths than as-extruded samples. Yield strength and strain hardening rate were found to increase and the ductility was found to decrease with increasing aluminum content.

32587 **An atomic model of crack tip deformation in aluminum using an embedded atom potential.** Hoagland, R.G. (Washington State University, Pullman, Washington 99164-2920 (USA)); Daw, M.S.; Foiles, S.M.; Baskes, M.I. *Journal of Materials Research (USA)*, 5(2): 313-324 (Feb 1990). DOE Contract FG06-87ER45287.

The atomic configuration at the tip of a mode 1 crack in aluminum is modeled by means of molecular dynamics calculations using an embedded atom potential. This potential intrinsically incorporates many-body contributions. This paper is concerned with the characteristics of the atomic displacement fields in comparison to the linear elastic predictions and dislocation emission phenomena. Three crack/crystal orientations are examined in which the crack plane-crack propagation directions are (010)-[100], $(\bar{1}10)$-[110], and $(\bar{1}10)$-[111]. The first two models behaved in a brittle fashion as dislocation emission did not occur for reasons associated with the use of periodic boundary conditions parallel to the crack front. For the models which remained atomically sharp, the positions of the atoms near the crack tip in equilibrium configurations are different from the linear elastic predictions but, to first order, retain an $r^{1/2}$ dependence, with smaller K, and with the origin displaced behind the physical crack tip. This near tip region is also observed to be elastically softer than in the far field. Dislocation emission readily proceeds in the $(\bar{1}10)$-[111] model by the sequential emission of partials with attendant nonzero u_z displacements. The blunting is characterized by the creation of two corner defects that separate as emission occurs and relaxation of the strains in the region initially confronted by the crack tip. Additional features of the results are discussed.

32588 **X-ray diffraction study of the Ni(111)5°[1$\bar{1}$0] vicinal surface.** Shen, Q. (Department of Applied and Engineering Physics, Cornell University, Ithaca, New York 14853 (US)—Department of Materials Science and Engineering, Cornell

Univesity, Ithaca, New York 14853 (US)); Chang, J.P.; Navrotski, G.; Blakely, J.M. *Physical Review Letters (USA)*, 64(4): 451-454 (22 Jan 1990). DOE Contract FG02-87ER45302;AC02-76CH00016.

We have studied the Ni(111)5°[1$\bar{1}$0] vicinal surface using high-resolution x-ray diffraction. The resolved two-peak profile in the scans perpendicular to the step direction is explained by a two-phase model in which the surface consists of two types of region, one with large terraces and the other with small terraces. Additional measurements as a function of sample temperature show evidence that the step arrangement undergoes a phase transition aroung 570 K, with step clustering at low temperatures.

32589 An analysis of the low temperature, low and high strain-rate deformation of Ti-6Al-4V. Follansbee, P.S. (Los Alamos National Lab., NM (USA)); Gray, G.T. *Metallurgical Transactions, A (Physical Metallurgy and Materials Science) (USA)*, 20A(5): 863-874 (May 1989).

The deformation behavior of Ti-6Al-4V at temperatures between 76 and 495 K, strain rates between 0.001 and 3000 s^{-1}, and compressive strains to 0.3 has been investigated. Measurements of yield stress as a function of test temperature, strain rate, and prestrain history are analyzed. The mechanical threshold stress (flow stress at 0 K) is used as an internal state variable, and the contributions to the mechanical threshold stress from the various strengthening mechanisms present in this alloy are analyzed. Transmission electron microscopy (TEM) is used to correlate deformation substructure evolution with the constitutive behavior. The deformation substructure of Ti-6-4 is observed to consist of planar slip in the α grains at quasistatic strain rates. At high strain rates, deformation twinning is observed in addition to planar slip. Increasing the temperature to 495 K is seen to alter the deformation mode to more random slip; the effect of this on the proposed deformation model is discussed.

32590 Microstructural trapping effects on hydrogen induced cracking of a microalloyed steel. Stevens, M.F. (Los Alamos National Lab., NM (USA)); Bernstein, I.M. *Metallurgical Transactions, A (Physical Metallurgy and Materials Science) (USA)*, 20A(5): 909-920 (May 1989).

This paper reports the susceptibility of a Ti microalloyed HSLA steel to internal hydrogen induced cracking correlated with the hydrogen trapping character of the microstructure. Both of these properties are influenced by aging reactions which determine the type and extent of carbide precipitation as well as metalloid segregation to grain boundaries. In turn, crack path susceptibility and total trapping character determine in large part the threshold and steady-state cracking propensities. Thus metalloid segregation concurrent with potent irreversible trap (TiC) precipitation results in low inherent toughness, but no appreciable drop in threshold stress intensity. Conversely, cementite precipitates formed at lower aging temperatures provide potent crack initiation sites in the absence of deep trapping, resulting in a lower threshold for cracking.

32591 Neutron scattering experiments on YbXCu$_4$ and ErXCu$_4$ (X=Au, Pd, and Ag). Severing, A. (Institut Laue-Langevin, Grenoble, France (FR)); Murani, A.P.; Thompson, J.D.; Fisk, Z.; Loong, C. *Physical Review, B: Condensed Matter (USA)*, 41(4): 1739-1749 (1 Feb 1990).

Temperature-dependent neutron scattering experiments with incident energies in the range 3–50 meV have been performed on polycrystalline samples of the heavy-electron system YbXCu$_4$, as well as the stable 4*f*-moment compounds ErXCu$_4$ and the nonmagnetic reference materials LuXCu$_4$, with X=Au, Pd, and Ag. The quasielastic linewidth of the YbXCu$_4$ compounds is determined as a function of temperature. For YbAuCu$_4$ a quantitative crystal-field analysis is applied to the observed inelastic response, while the data for the strongly 4*f*-delocalized compound YbAgCu$_4$ are discussed in terms of a possible crystal-field interpretation and various theoretical models for heavy-electron systems.

32592 Piezochromism: Pressure-induced isomerizations in the tetrachlorocuprate anion in the solid state with various cations. Bray, K.L. (Univ. of Illinois, Urbana-Champaign (USA)); Drickamer, H.G. *Journal of Physical Chemistry (USA)*, 94(5): 2154-2159 (8 Mar 1990). DOE Contract AC02-76ER01198.

The effects of high pressure on Cs_2CuCl_4, bis(trimethylbenzylammonium) tetrachlorocuprate, (N-phenylpiperazinium) tetrachlorocuprate, bis(N-benzylpiperazinium) tetrachlorocuprate bis(hydrochloride), and bis(N-methylphenethylammonium) tetrachlorocuprate are reported. Electronic spectroscopy indicates molecular rearrangements in the tetrachlorocuprate ions with increasing pressure. The changes in geometry and nature of the rearrangements are discussed.

32593 Experimental equations of state for calcium, strontium, and barium metals to 20 kbar from 4 to 295 K. Anderson, M.S. (Ames Laboratory-U.S. Department of Energy, Iowa State University, Ames, Iowa 50011 (US)); Swenson, C.A.; Peterson, D.T. *Physical Review, B: Condensed Matter (USA)*, 41(6): 3329-3338 (15 Feb 1990). DOE Contract W-7405-ENG-82.

Piston-displacement measurements have been used to determine the equations of state of high-purity calcium and strontium (both fcc) and barium (bcc) metals to 20 kbar from 4 to 295 K. For each metal, the results have roughly 1% accuracy for the P=0 bulk modulus at 295 K and for the total volume change with pressure. The results also give the change with temperature of both the P=0 volume and the isothermal bulk modulus for these metals. While the bulk moduli for calcium and strontium are dependent only on the volume, those for barium show a significant temperature dependence with decreasing volume. Specifically, the bulk modulus for barium at 10 kbar is roughly 3% smaller at 295 K than would be predicted from the 0-K value at the same volume. Differences between the pressure-volume relations for bare samples and for those which were jacketed with indium metal are not understood.

32594 Core-level photoemission from alkali metals on Ru(001). Shek, M. (Department of Physics, Hunter College of The City University of New York, New York, New York 10021 (USA)); Hrbek, J.; Sham, T.K.; Xu, G. *Physical Review, B: Condensed Matter (USA)*, 41(6): 3447-3454 (15 Feb 1990). DOE Contract AC02-76CH00016.

We report soft-x-ray photoemission results on the core-level binding energies of Li, Na, K, and Cs adsorbed on Ru(001). For all four alkali metals, the saturated alkali-metal–Ru interface core level and the second- (surface-) layer core-level binding energies differ by as much as 0.85–1.25 eV. Surface versus bulklike core-level shifts are reported for Li, K, and Cs, which are 0.55 eV for Li and ~0.25 eV for the other two. For increasing coverages of Li, Na, and K in direct contact with Ru, there are significant decreases in the core-level binding energies, the total shift ranging from ~−1.25 eV for Li to ~−0.80 eV for K; the shift for Cs is small and the reasons for the deviation are discussed. A comparison between our observations and the prediction from the thermodynamic model of Johannson and Martensson is also given.

32595 Electrical and thermal properties of neutron-transmutation-doped Ge at 20 mK. Wang, N. (Department of Physics, University of California, Berkeley, California 94720 (USA)— Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720 (USA)); Wellstood, F.C.; Sadoulet, B.; Haller, E.E. *Physical Review, B: Condensed Matter (USA)*, 41(6): 3761-3768 (15 Feb 1990). DOE Contract AC03-76SF00098.

We report on hot-electron effects in neutron-transmutation-doped Ge (NTD Ge) near 20 mK. Both static and dynamic electrical properties were measured and compared with a model including both variable-range-hopping conduction and hot-electron effects.

32596 Proximity effect in superconducting bilayers and multilayers. Aarts, J. (Kamerlingh Onnes Laboratorium, Leiden University, Post Office Box 9506, 2300 RA Leiden, The Netherlands (NL)); Meiresonne, J.; Sprey, H.; Maj, W.; Zagwijn, P. *Physical Review, B: Condensed Matter (USA)*, 41(7): 4739-4742 (1 Mar 1990).

Measurements of the superconducting transition temperature T_c of bilayers and multilayers of $Mo_{69}Si_{31}/Mo_{47}Si_{53}$ are presented. For the multilayers the results can be described in terms of the de Gennes–Werthamer theory for the proximity effect, without adjustable parameters. For the bilayers it is shown that a depression of T_c occurs which can be described by the effects of weak localization in the same way as is already known for single thin films.

32597 Atomic and electronic structure of the NiAl(111) surface. Kang, M.H. (The Laboratory for Research on the Structure of Matter, University of Pennsylvania, Philadelphia, Pennsylvania 19104-6202 (USA)); Lui, S.; Mele, E.J.; Plummer, E.W.; Zehner, D.M. *Physical Review, B: Condensed Matter (USA),* 41(8): 4920-4929 (15 Mar 1990). DOE Contract AC05-84OR21400.

There are two possible terminations for the ideal NiAl(111) surface, i.e., all Al or all Ni on the surface atomic layer. We investigate which termination occurs on the NiAl(111) surface by comparing the pseudopotential electronic band structure of a Ni-terminated and an Al-terminated NiAl(111) surface with the angle-resolved photoemission data on a NiAl(111) sample. The measured surface band structure shares common features partly with that of the Ni termination and also partly with that of the Al termination, which supports the theory that the real NiAl(111) surface is composed of both Ni- and Al-terminated (111) domains, as suggested by a recent low-energy electron diffraction (LEED) study. We also determine the relaxation of the two outermost atomic layers for both terminations by the pseudopotential total-energy calculations and compare them with the LEED results. We find that the present results are in good agreement with the LEED analysis for Ni termination, but in qualitative disagreement for Al termination.

32598 Light scattering by surface acoustic waves on corrugated metal surfaces. Robertson, W.M. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439-4843 (USA)); Grimsditch, M.; Moretti, A.L.; Kaufman, R.G.; Hulse, G.R.; Fullerton, E.; Schuller, I.K. *Physical Review, B: Condensed Matter (USA),* 41(8): 4986-4992 (15 Mar 1990). DOE Contract W-31109-ENG-38;FG03-87ER45332.

We report the results of a Brillouin-scattering study of corrugated Ag surfaces. The corrugation plays a dramatic role in the wave-vector–selection rules governing coupling to surface phonons, and this effect is substantially different when the effective wave vector of the surface corrugation is collinear or perpendicular to the scattering plane. In processes that involve the grating wave vector, we show that the coupling mechanism between light and phonons is governed by surface plasmons which introduce a new scattering interaction with unusual polarization features in the Brillouin-scattering process.

32599 Determination of the bulk band structure of Ag in Ag/Cu(111) quantum-well systems. Mueller, M.A. (Department of Physics, University of Illinois at Urbana-Champaign, 1110 West Green Street, Urbana, Illinois 61801 (USA)— Materials Research Laboratory, University of Illinois at Urbana-Champaign, 104 South Goodwin Avenue, Urbana, Illinois 61 *Physical Review, B: Condensed Matter (USA),* 41(8): 5214-5220 (15 Mar 1990). DOE Contract AC02-76ER01198.

Ag is grown epitaxially on Cu(111) to form quantum wells. The resulting quantum-well states and resonances, observed with angle-resolved photoemission, exhibit shifts in energy for varying emission directions and for changing Ag-film thicknesses. The results are utilized in a determination of the Ag bulk *sp*-band dispersion relation near the *L* point in the Brillouin zone. Effective masses and the Fermi surface near the *L* point are deduced. The Fermi surface agrees well with that obtained earlier from de Haas–van Alphen measurements.

32600 Abrupt interfaces with novel structural and electronic properties: Metal-cluster deposition and metal-semiconductor junctions. Waddill, G.D. (Department of Chemical Engineering—Department of Materials Science, University of Minnesota, Minneapolis, Minnesota 55455 (USA)); Vitomirov, I.M.; Aldao, C.M.; Anderson, S.G.; Capasso, C.; Weaver, J.H.; Liliental-Weber, Z. *Physical Review, B: Condensed Matter (USA),* 41(8): 5293-5305 (15 Mar 1990). DOE Contract AC03-76SF00098.

Abrupt interfaces with no observed substrate disruption are produced by a novel method of metal-semiconductor junction formation. This method involves the condensation of a thin Xe buffer layer on cleaved surfaces to isolate the semiconductor from impinging metal atoms. This Xe buffer layer provides a surface upon which the metal atoms diffuse, nucleate, and grow into metallic clusters. These clusters are then brought into contact with the substrate when the Xe is thermally desorbed. The result is an abrupt, nondisrupted, nearly ideal interface. Photoemission studies of Al, Ag, Au, Ga, Ti, and Co clusters grown on *n*- and *p*-type GaAs(110) show unique Fermi-level positions ~0.3 and 1.0 eV below the conduction-band minimum, respectively, that are nearly metal and coverage independent. We find no evidence that metal-induced gap states or conventional defect levels are important in determining the Fermi-level position in the gap, but photoemission results indicate surface unrelaxation around the clusters. This unrelaxation results in the reappearance of states in the gap. High-resolution electron-microscopy results for Au(clusters)/GaAs(110) show intimate contact with no intermixing at the interface, with sintering of Au clusters to form an interconnected network of metal islands at high coverages. Comparisons of these results with those for interfaces formed by atom deposition at 60 and 300 K emphasize the novel properties of the cluster interface.

32601 Multiple sulfur sites in the Cu(100)$p(2\times2)$-S surface structure. Ma, Y. (AT&T Bell Laboratories, Murray Hill, New Jersey 07974 (USA)); Rudolf, P.; Chaban, E.E.; Chen, C.T.; Meigs, G.; Sette, F. *Physical Review, B: Condensed Matter (USA),* 41(8): 5424-5427 (15 Mar 1990). DOE Contract AC02-76CH00016.

High-resolution S 2*p* photoemission spectra of the saturated Cu(100)$p(2\times2)$-S surface show multiple peaks, indicating that sulfur atoms adsorb on multiple sites. This result is related to the domain structure of the adsorbate overlayer, and assigned to sulfur atoms adsorbed within $p(2\times2)$ domains or at the boundaries between adjacent domains. The observed difference in core-level binding energies for these two sulfur locations is interpreted as due to frustrated substrate surface reconstruction of the copper atoms at the interdomain boundaries.

3602 Ceramics, Cermets, and Refractories

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32602 (CBPF-NF–028/89) **Dynamical information for Fe doped $YBa_2Cu_3O_7$ superconducting oxides obtained from high temperature Moessbauer studies.** Saitovitch, E.B. (Bochum Univ. (Germany, F.R.)); Scorzelli, R.B.; Azevedo, I.S.; Micklitz, H. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 26p. Order Number DE90627871. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In situ high temperature ^{57}Fe Moessbauer measurements were performed on samples of $YBa_2(Cu_{1-x}Fe_{x3}O_{7-\delta})$, in pure oxygen or in air, both at a pressure of about 1 atm. Three samples were studied with x = 0.005 and 0.010, respectively in the temperature range from 295 to 640 K. As in previously published papers, the fitted quadrupole doublets were associated to different oxygen configurations around the Fe ions on the Cu(1) chain site, whose temperature dependent behavior can be summarized: (i) the f-factor for the different configurations are very similar; (ii) the effective Debye temperature ($\simeq$ 350 k) is rather insensitive to the Fe content and oxygen coordination; (iii) the electronic configuration of Fe is very stable up 320 C; (iv) the quadrupole splitting q(T) can be well described within the picture use for non cubic metals, Finally a partial change from doublet A to B induced by temperatures is observed. This change is completely or partially reversible, depending on the sample. (author).

32603 (CEA-R–5489) **Investigation on U - O - Na, Pu - O - Na and U,Pu - O - Na phase diagrams.** Pillon, S. CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France); Montpellier-2 Univ., 34 (France). Mar 1989. 270p. (In French). Order Number DE90793017. Available from NTIS (US Sales Only), PC A12/MF A01.

The thermochemical interaction between the nuclear fuel (uranium and plutonium mixed oxides) and the sodium has been investigated and particularly the three phase diagrams: U - O - Na; Pu - O - Na; U,Pu - O - Na. High temperature neutron diffraction, microcalorimetry and powder X-ray diffraction were used for the characterization of the compounds synthetized. This study allowed to complete the knowledge about each of these diagrams and to measure some physical and thermal properties on the compounds.

The limits on the modelization of the fuel-sodium interaction are discussed from the results of the UO_2 - Na reaction.

32604 (CONF-900432–1) **In-situ growth of superconducting films of Bi-Sr-Ca-Cu-O using magnetron sputtering.** Kampwirth, R.T.; Grace, J.M.; Miller, D.J.; McDonald, D.B.; Gray, K.E.; Andersen, P.H.; Driehuys, B.; Reiten, M.; Ascolese, M. Argonne National Lab., IL (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract W-31109-ENG-38. From Science and technology of thin-film superconductors conference; Golden, CO (USA); 30 Apr - 4 may 1990. Order Number DE90011161. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Growing superconducting films of the high-temperature superconductors (HTS) in a single-step process within the vacuum system and at lower temperatures than post-annealed films has been the goal of many researchers. This has been achieved in $YBa_2Cu_3O_7$ at a number of laboratories, but Bi and Tl-based HTS have proven more difficult. We report superconducting films of $Bi_2Sr_2CaCu_2O_x$ and $Bi_2Sr_2Ca_2Cu_3O_x$ made by magnetron sputtering from a bismuth enriched composite target, onto MgO at substrate temperatures ≈150°C lower than required for post-annealed films. These films show highly c-axis oriented growth without the need for epitaxy, which suggests that films might be grown on a variety of substrates both with and without a buffer layer. The exact mechanism of crystallization at such low temperatures is not yet known, but it can be speculated that the surface atoms are less constrained and thus have a smaller energy barrier to overcome in forming a crystal structure. There is a narrow temperature window for growth of the superconducting phase; at lower temperatures the films tend to be semiconducting, due probably to lack of sufficient thermal energy to crystallize a well-ordered phase. At higher temperatures the bismuth sticking coefficient decreases to the point where no bismuth remains and the films are insulating. 8 refs., 7 figs.

32605 (CONF-900466–45) **Microwave processing of silicon nitride.** Tiegs, T.N.; Kiggans, J.O. Jr.; Kimrey, H.D. Jr. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90011333. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Microwave sintering of Si_3N_4-based materials showed improved densification as compared to samples heated conventionally under similar conditions. Accelerated nitridation of Si in the microwave furnace to produce Si_3N_4 was also observed. Dense Si_3N_4, annealed by microwave heating, exhibited enhanced grain growth; however preferential coupling of the microwave power to the grain-boundary phases in the present experiments resulted in their degradation. 9 refs., 3 figs., 1 tab.

32606 (CONF-900634–1) **Ceramic epitaxial films and multilayers prepared by MOCVD.** Chang, H.L.M.; You, H.; Parker, J.C.; Guo, J.; Gao, Y.; Lam, D.J. Argonne National Lab., IL (USA). Apr 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 7. world ceramics congress: ceramics today–tomorrow's ceramics; Montecatini Terme (Italy); 24-30 Jun 1990. Order Number DE90011090. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Titanium and vanadium oxide systems were selected to study the MOCVD process for the growth of epitaxial thin films in single- and multilayer configurations. Epitaxial TiO_2 and VO_2 films were obtained on sapphire (1120), (0001), and (1102) but not on Si (111). Six distinct substrate-film epitaxy relationships have been determined by carefully performed x-ray epitaxy relationships have been determined by carefully performed x-ray diffraction studies using a four-circle x-ray diffractometer. It is concluded that substrate materials and surface orientations are the most important factors for epitaxial film growth while growth temperature seems to play a secondary role. Detailed matching of local atomic arrangements between the film and substrate at the interface is discussed. 5 refs., 6 figs.

32607 (CONF-900709–1) **Superconducting thin films of YBaCu oxides prepared by MOCVD.** Bai, G.R.; Gao, Y.; Shi, H.; Chang, H.L.M.; Parker, J.C.; Lam, D.J. Argonne National Lab., IL (USA). Apr 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Symposium on high temperature superconductors of the 7th world ceramic congress; Trieste (Italy); 2-5 Jul 1990. Order Number DE90011109. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Thin films of Y–Ba–Cu–O system with Y:Ba:Cu ratio of 1:2:3 have been prepared by MOCVD technique with a cold wall atmospheric/low pressure system. The film composition, crystallinity, morphology, and superconducting properties as a function of chemical precursor, gas pressure, flow rate, substrate materials and deposition temperatures are systematically studied. A variety of experimental tools are used to study the structure-property relationships. The effects of processing variables on the film morphology and superconducting properties will be presented and discussed. 10 refs., 6 figs.

32608 (CONF-900764–1) **Cyclic damage zones ahead of tensile fatigue cracks in ceramic materials.** Suresh, S. (Brown Univ., Providence, RI (USA). Div. of Engineering); Brockenbrough, J.R. Brown Univ., Providence, RI (USA). Div. of Engineering. Nov 1989. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER45167. From Fatigue '90 international conference; Honolulu, HI (USA); 15-20 Jul 1990. Order Number DE90008372. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The development of a reversed flow or cyclic plastic zone is known to play an important role in influencing the growth of fatigue cracks in ductile metals subjected to constant and variable amplitude cyclic loads. In this paper, we present a detailed finite element analysis of the evolution of cyclic damage zones ahead of stationary cracks in brittle materials subjected to zero-tension fatigue loading. The damage mechanism considered here involves isotropic microcracking along grain boundaries and/or interfaces. It is shown that cyclic damage zones are induced ahead of tensile fatigue cracks in microcracking brittle solids when there is irreversible deformation at the crack-tip. The size of the cyclic damage zone and the variation of residual stress fields within the zone have been computed as a function of the extent of irreversibility of crack-tip damage. 15 refs., 5 figs.

32609 (CONF-9004201–1) **Friction and wear of whisker-reinforced ceramic composite bodies.** Yust, C.S. Oak Ridge National Lab., TN (USA). [1990]. 20p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From ASM international conference: tribology of composites; Oak Ridge, TN (USA); 30 Apr 1990. Order Number DE90011313. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An overview of the wear behavior of such a recent material development as whisker-reinforced ceramics will necessarily depend on limited sources. In fact, the literature contains very few references to wear studies in materials of this type. Whisker composites are an emerging material and it could hardly be expected that their behavior would be well characterized at this time, particularly with regard to wear behavior. Results of whisker composite wear studies which have been performed at ORNL have been summarized, as have relevant published data. The results presented in this paper, however, do more to indicate the need for additional work than to offer a complete body of knowledge. The results contained within this proceedings may prove to be one of the most concentrated collections of information to date on this topic. A conclusion which may be drawn by this overview is that wear behavior in whisker-reinforced ceramics can be complex and requires careful examination. The results indicate that the increased strength and fracture toughness produced by the inclusion of whiskers in ceramics may be offset by the introduction of phase interfaces subject to the action of dynamic stress states. Examples have been presented in this paper of the well-known transition from mild to severe wear which is so characteristic not only of the wear of ceramics but of other materials, as well. Most ceramic wear testing to date indicates that unlubricated use of ceramics as machine components is not likely to be successful, except under very mild contact conditions.

32610 (DOE/ER/45167–2) **Fatigue crack growth in ceramic materials at ambient and elevated temperatures.** Suresh, S. Brown Univ., Providence, RI (USA). Div. of Engineering. Nov 1989.

10p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER45167. (CONF-900764–2: Fatigue '90 international conference, Honolulu, HI (USA), 15-20 Jul 1990). Order Number DE90008418. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The mechanics and mechanisms of stable fatigue crack growth in a wide variety of ceramics and ceramic composites are examined in detail. Experimental results on crack growth, numerical analyses and microscopic observations of crack-tip damage zones are presented to illustrate fatigue processes with: (1) a mode of failure that is distinctly different from that seen under static loads; (2) kinematic irreversibility of microscopic deformation which leads to cyclic damage zones, analogous to cyclic plastic zones in metal fatigue; and (3) crack velocities which are distinctly different from those found under static load failure due to a mechanical-environmental synergistic effect or as a result of purely mechanical contact phenomena such as crack closure, crack bridging by grains or reinforcements, or wedging of crack faces by debris particles. 19 refs., 6 figs.

32611 (DOE/ER/45341–3) **Protons and lattice defects in perovskite-related oxides: Progress report, July 1, 1989–April 30, 1990.** Nowick, A.S. Columbia Univ., New York, NY (USA). Henry Krumb School of Mines. [1990]. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER45341. Order Number DE90010957. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The recent work on this project has focused on two perovskite-structured materials: single crystalline $KTaO_3$ doped with iron-group ions, and ceramic $BaCeO_3$ doped with Nd, Gd, Sc and Ca. In the case of $KTaO_3$, we have shown that protons are introduced into the crystal from H_2O vapor so that it becomes primarily a protonic conductor. The defect reactions involved have been considered in detail with the aid of EPR and IR measurements. In the study of $BaCeO_3$, it was found that the Nd-doped material is an excellent protonic conductor with activation energy for proton hopping of only 0.54 eV. In addition, weight-change measurements were used to determine the amount of water uptake, while Nernst-cell measurements gave values for the transport numbers of oxygen and of protons. In contrast to the case of Nd doping, Gd or Yb-doped material are not protonic conductors. Other studies include those of high-$T_c$superconductors, the first showing a large elastic constant and internal friction anomaly in $La_{2x}Sr_xCuO_4$, and the second showing under what conditions degradation occurs due to H_2O and CO_2 annealing treatments. Finally, a study of dielectric loss in Li-borate glasses shows that the dielectric loss peak in glasses widely believed to be due to a bulk phenomenon, is actually an electrode blocking effect.

32612 (EGG-M–89144) **A particle-level numerical simulation of the dynamic consolidation of a metal matrix composite material.** Williamson, R.L.; Wright, R.N. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 5p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-890812–66: American Physical Society topical conference on shock compression of condensed matter, Albuquerque, NM (USA), 14-17 Aug 1989). Order Number DE90010950. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Dynamic consolidation of a SiC fiber reinforced aluminum matrix composite is simulated using a particle-level numerical model. Simulation results are compared with the microstructure of a composite formed using a plate impact to consolidate a close-packed array of aluminum wires containing SiC fibers of the appropriate diameter to fill in the interstices approximating the geometry of the model. With respect to the observed deformation and the location and extent of melting of the aluminum wires, the simulation predictions are in good agreement with the experiment. 6 refs.

32613 (LBL–28863) **Effect of Cu^{2+} magnetic moments on the superconductivity of $YBa_2Cu_3O_7$: The origin of the "linear term" in the specific heat; The volume fraction of superconductivity.** Phillips, N.E.; Fisher, R.. Lawrence Berkeley Lab., CA (USA). Apr 1990. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-9004184–2: 25. Yamada conference on magnetic phase transitions, Osaka (Japan), 13-16 Apr 1990). Order Number DE90011214. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The concentration (n_2) of Cu^{2+} magnetic moments located on the $YBa_2Cu_3O_7$ lattice is determined by the specific heat in a 7-T magnetic field. The discontinuity in specific heat at $T_c[\Delta C(T_c)]$ and also the coefficient of the linear term $[\gamma(0)]$ are correlated with n_2 in a way that suggests the operation of a pair-breaking mechanism that limits the transition to the superconducting states and provides a criterion for the volume fraction of superconductivity. $\gamma(0)$ can be represented by the sum of two contributions, both associated with Cu^{2+} moments, implying that there is no contribution that is an intrinsic property of the superconducting state. The interpretation of the data provides estimates of parameters relevant to the recognition of strong-coupling effects. 12 refs., 5 figs.

32614 (NAGRA-NTB–89-13) **Subcritical crack growth in hot-isostatically postcompacted high-grade alumina.** Fett, T. (Kernforschungszentrum Karlsruhe, Inst. fuer Material- und Festkoerperforschung IV (Germany, F.R.)); Hartlieb, W.; Keller, K.; Munz, D.; Rieger, W. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Apr 1989. 18p. Available from Nagra, CH-5401 Baden, Switzerland.

The subcritical crack-growth behaviour of natural cracks in a hot isostatically post-compacted high-grade alumina ceramic was tested in a concentrated salt solution at 70°C. The results of static bending tests yielded a crack-growth law that can be described by a power law with an exponent n=73.5. This high value reflects an excellent resistance to subritical crack growth. A comparison with Al_2O_3-materials investigated earlier has been included. (author) 1 tab., 8 figs., 6 refs.

32615 (SAND–90-1111C) **Properties of films prepared from low surface area/density alumina-silica.** Hietala, S.L. (New Mexico Univ., Albuquerque, NM (USA)); Smith, D.M.; Hietala, V.M.; Frye, G.C.; Hurd, A.J.; Brinker, C.J. Sandia National Labs., Albuquerque, NM (USA). [1990]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900466–36: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90011048. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A sol-gel method was use to prepare bulk, closed pore, amorphous alumina-silica. Films prepared from this 47wt% Al_2O_3- SiO_2 composition were examined by SAW, elipsometry and electrical measurements. The films were found to have a surface area of 1.1 cm^2/cm^2, a refractive index of 1.44 at 633 nm, and a relative permittivity of 6.2 at 200 KHz. These properties indicate potential applications as hermetic seals, barrier coatings, dielectric layers for capacitors and passivation coatings for electronic circuits.

32616 (SAND–90-1229C) **Rapid thermal processing of high temperature superconducting fiber.** Halloran, J.W. (CPS Superconductor Corp., Milford, MA (USA)); Neal, M.J.; Ginley, D.S.; Venturini, E.L.; Kwak, J.F.; Baughman, R.J.; Mitchell, M.A.; Morosin, B.; Basu, S.N.; Mitchell, T.E. Sandia National Labs., Albuquerque, NM (USA). [1990]. 7p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract AC04-76DP00789;W-7405-ENG-36. Contract N00014-88-C-0512;Contract NAS-3-25876;Agreement CRDA-89 (CONF-900466–44: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90011236. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We report on the rapid thermal processing (RTP) of Y-123 fibers with and without presintering to form the orthorhombic phase. We show that fibers which were originally semiconducting and tetragonal before rapid thermal processing form normal twinned orthorhombic material after processing for 2–4 seconds at > 1000°C with a 3 min. cool down in oxygen. They subsequently show $T_c$to 90K and magnetization indicative of substantial diamagnetic shielding. We present the effects of varying the RTP parameters on the morphology, phase, and superconducting properties of a number of tetragonal and orthorhombic Y-123 fibers. 2 refs., 5 figs., 1 tab.

32617 **Multicomponent ultrafine microstructures.** Materials Research Society symposium proceedings. Volume 132. McCandlish, L.E. (Rutgers–the State Univ., Piscataway, NJ (USA)); Kear, B.H.; Polk, D.E.; Siegel, R.W. 243p. Materials Research Society,

Pittsburgh, PA (USA) (1989). Grant DAAL03-89-G-0001. (CONF-8811279–: Multicomponent ultrafine microstructures, Boston, MA (USA), 30 Nov - 1 dec 1988).

In these proceedings, the 33 articles are organized under four main headings: ceramics; composites; alloys, metals, and magnetic materials; multilayers and superlattices. At this stage in the development of the field, research emphasis is on the synthesis and characterization of novel nanophase materials. Chemical and physical vapor deposition techniques remain one of the most active research areas in the synthesis of nanophase materials. A growing activity in the chemical synthesis of nanophases is apparent. Such methods depend on controlled thermochemical conversion of precursor molecules to achieve the desired ultrafine microstructures. A major effort is being made to characterize the intergranular and interphase interfaces using x-ray and neutron scattering, Mössbauer spectroscopy and coercivity measurements, atom probe, and high resolution electron microscopy. Controversy still exists regarding the nature of grain boundaries in nanophase materials produced by compaction of fine powders. Some authors claim that these boundaries have a random gas-like structure, whereas others contend that the boundaries are of conventional type, although perhaps containing a distribution of small pores. Major contributions have been made in the determination of magnetic and mechanical properties.

32618 Superconductivity and magnetic scattering in the $Nd_{2-x}Ce_xCuO_{4-\delta\delta}$. Peng, J.L. (California Univ., Davis, CA (USA). Dept. of Physics); Shelton, R.N.; Radousky, H.B. 89-90 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Samples of $Nd_{2-x}Ce_xCuO_{4-\delta}$ were prepared by annealing both in air and under vacuum. The authors report that electrical resistivity measurements showed that these materials in their normal state demonstrate a Kondo anomaly resulting from a combination of magnetic and phonon scatterings.

32619 $La_2CuO_{4+\delta\delta}$and $La_2NIO_{4+\delta\delta}$: Phase separation resulting from excess oxygen defects. Dabrowski, B. (Argonne National Lab., IL (USA). Materials Science and Technology Div.); Jorgensen, J.D.; Hinks, D.G.; Pei, S.; Richards, D.R.; VanFleet, H.B.; Decker, D.L. 99-100 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The structural, superconducting and magnetic properties of $La_2CuO_{4+\delta}$ and $La_2NiO_{4+\delta}$ were studied by neutron powder diffraction, thermogravimetric analysis, resistivity and magnetic susceptibility measurements. The authors report that $La_2CuO_{4+\delta}$ was found to phase separate around 320K into antiferromagnetic $La_2CuO_{4+\delta}$, for $0.02 \leq \delta \leq 0.13$ the system separates into two phases with different defect concentrations and structures. The structure of the interstitial oxygen defect was determined for $La_2NiO_{4.18}$.

32620 Synthesis, characterization, and properties of nanophase ceramics. Siegel, R.W. (Materials Science Div., Argonne National Lab., Argonne, IL (US)); Eastman, J.A. 3-14 of Multicomponent ultrafine microstructures. McCandlish, L.E.; Kear, B.H.; Polk, D.E.; Siegel, R.W. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-8811279–: Multicomponent ultrafine microstructures, Boston, MA (USA), 30 Nov - 1 dec 1988).

Ultrafine-grained ceramics have been synthesized by the production of ultrafine (2–20 nm) particles, using the gas-condensation method, followed by their in-situ, ultra-high vacuum consolidation at room temperature. These new nanophase ceramics have properties that are significantly improved relative to those of their coarser-grained, conventionally-prepared counterparts. For example, nanophase rutile (TiO_2) with an initial mean grain diameter of 12 nm sinters at 400 to 600°C lower temperatures than conventional powders, without the need for compacting or sintering aids. The sintered nanophase rutile exhibits both improved microhardness and fracture characteristics. These property improvements result from the reduced scale of the grains and the increased cleanliness of the particle surfaces and the subsequently-formed grain boundaries. Research completed on the synthesis, characterization, and properties of nanophase ceramics is reviewed and the potential for using the nanophase synthesis method for engineering new and/or improved ceramics and composites is considered.

32621 Sintering of nanophase TiO_2 at 550°C. Epperson, J.E. (Argonne National Lab., Argonne, IL (US)); Siegel, R.W.; White, J.W.; Klippert, T.E.; Narayanasamy, A.; Eastman, J.A.; Trauw, F. 15-20 of Multicomponent ultrafine microstructures. McCandlish, L.E.; Kear, B.H.; Polk, D.E.; Siegel, R.W. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-8811279–: Multicomponent ultrafine microstructures, Boston, MA (USA), 30 Nov - 1 dec 1988).

Samples of nanophase TiO_2 were prepared by the condensation of Ti vapors into clusters, their in situ oxidation to TiO_2, and their consolidation into thin disks. Small angle neutron scattering was measured in the as-consolidated condition and after selected isothermal sintering anneals of up to 23 h at 550°C. The maximum entropy analysis method was used to obtain the size distributions of the scattering centers from the scattering curves. The results are interpreted in terms of a microstructural model consisting of nanometer sized grains of TiO_2 separated by about 0.5 nm wide boundary regions, which contain voids and TiO_2 of { <=} 60–70% of bulk density.

32622 Small angle neutron scattering from nanophase titanium as a function of oxidation. Eastman, J.A. (Argonne National Lab., Argonne, IL (US)); Epperson, J.E.; Hahn, H.; Klippert, T.E.; Narayanasamy, A.; Ramasamy, S.; Siegel, R.W.; White, J.W.; Trouw, F. 21-26 of Multicomponent ultrafine microstructures. McCandlish, L.E.; Kear, B.H.; Polk, D.E.; Siegel, R.W. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-8811279–: Multicomponent ultrafine microstructures, Boston, MA (USA), 30 Nov - 1 dec 1988).

Nanophase titanium, prepared by the gas-condensation method both as aggregated powder and in lightly compacted discs, has been studied by conventional small angle neutron scattering, and by use of contrast variation methods. The contrast has been changed isotopically, by means of deuterated/protonated solvent distilled into the specimen and by progressive incremental oxidation of the Ti particles using fixed doses of low-pressure oxygen. It is shown that some evolution of the small angle pattern for lightly compacted nanophase Ti occurred over a period of several months at 300 K. Contrast matching by external solvent works well and has allowed the scattering lengths of oxidized and unoxidized specimens to be followed. The results imply that the scattering from metal and oxide can be separated under suitable conditions. The partial oxidation experiments indicate that there is both a fast and slow oxidation at 300 K. Also, during slow oxidation, high scattering length density scattering centers were formed whose number increased, but whose size remained the same at about 2 nm; these centers are tentatively assumed to be TiO_2.

32623 Phase control of nanophase materials formed from ultrafine Ti of Pd powders. Eastman, J.A. (Materials Science Div., Argonne National Lab., Argonne, IL (US)). 27-34 of Multicomponent ultrafine microstructures. McCandlish, L.E.; Kear, B.H.; Polk, D.E.; Siegel, R.W. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-8811279–: Multicomponent ultrafine microstructures, Boston, MA (USA), 30 Nov - 1 dec 1988).

The effect of He gas pressure during evaporation and post-evaporation O_2 exposure on phase formation in nanophase materials has been examined. Ultrafine powders of Ti and Pd were prepared by the inert gas-condensation technique and bulk nanophase samples were formed by consolidation of these powders with or without prior exposure to O_2. Evaporation of Ti in He pressures greater than 500 Pa followed by exposure to O_2 results

in the formation of ultrafine powders of crystalline rutile (TiO_2) which are compacted to form nanocrystalline TiO_2. Surprisingly, reducing the He pressure used during evaporation to less than approximately 500 Pa results in the formation of ultrafine powders of an amorphous phase. Room temperature consolidation of this powder under vacuum, however, results in nanocrystalline Ti being formed if the powder is not exposed to O_2 prior to consolidation, and a mixture of rutile and an unidentified crystalline phase if the powder has been previously exposed to O_2. Further reduction of the He pressure during evaporation of Ti to less than approximately 10 Pa results in the formation of crystalline Ti having a film-like morphology rather than the desired ultrafine particles. Experiments on Pd evaporated in 10 to 6000 Pa of He have yielded ultrafine powders and consolidated samples of only the crystalline fcc phase, regardless of the He pressure.

32624 **Microstructure of nonocrystalline ceramics.** Hahn, H. (Univ. of Illinois, Urbana, IL (US)); Logas, J.; Hofler, H.J.; Bier, Th.; Averback, R.S. 35-39 of Multicomponent ultrafine microstructures. McCandlish, L.E.; Kear, B.H.; Polk, D.E.; Siegel, R.W. Materials Research Society, Pittsburgh, PA (USA) (1989). Contract DAAL03-88-K-0094. (CONF-8811279–: Multicomponent ultrafine microstructures, Boston, MA (USA), 30 Nov - 1 dec 1988).

This paper reports the microstructure of nanocrystalline (n –) TiO_2 studied as a function of sintering temperature up to 1273 K. Grain growth was monitored using x-ray diffraction and scanning electron microscopy. Measurements of density and permeability of He and Ar were also conducted. The specific surface area and the total pore volume were determined quantitatively using the nitrogen adsorption method. These measurements revealed that high compacted n-TiO_2 had green body densities as high as 75% of bulk density and that sintering occurred at much lower temperatures than in conventional powder. Densification proceeded by loss of the small pores first. The possibilities of achieving high densities with limited grain growth are discussed.

32625 **Effect of electron and volume change via SB (V) doping on the superconducting behavior of $K_{0.14}Ba_{0.6}Bi_{1-x}Sb_xO_3$.** Dabrowski, B. (Argonne National Lab., IL (USA)); Richards, D.R.; Hinks, D.G.; Hannon, R.H.; Lee, H.; Melim, V.J.; Peng, W.; Kimball, C.W. 91-92 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

This paper reports the effect of Sb-substitution for Bi which has been studied in the oxide superconductors $K_{0.4}Ba_{0.6}Bi_{1-x}Sb_xO_3$ ($\leq x \leq 0.4$). The compounds are single phase to near $x = 0.3$. T_c is depressed from 28K for $x = 0$ to below 2K for $x = 0.3$. Resistance vs T behavior is semiconductor-like for low x, but becomes metallic-like as x increases. Mossbauer effect measurements show that the valence of Sb is near 5+ for all Sb concentrations to $x = 0.4$.

32626 **Chemistry and superconducting behavior of Sb-substituted Bi/Pb-based oxides.** Kimball, C.W. (Northern Illinois Univ., Dekalb, IL (USA)); Peng, W.; Hannon, R.H.; Lee, H.; Genis, A.P.; Melim, V.J.; Dabrowski, B.; Richards, D.R.; Hinks, D.G. 95-96 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

This paper discusses the effect of Sb-substitution for Bi which has been studied in the high T_c Bi-based oxide superconducting compounds $Pb_{0.3}Bi_{1.8-x}Sb_xSr_{1.9}Ca_2Cu_3O_y$ ($0 < x \leq 0.3$). The solubility of Sb is quite low and its substitution for Bi leads to a complex chemistry with the formation of a new phase whose fractional concentration increases with increasing Sb content. The superconducting T_c is depressed by the addition of Sb for materials prepared in an oxidizing atmosphere, but is not affected if preparation is in a mildly oxidizing atmosphere. No T_c above 110K is found for any Sb-doped Pb/Bi 2223 compounds. A^{121} Sb Mčharssbauer effect study of the microchemistry shows that Sb is in a valence state near 5+ for all compositions.

32627 **Metal silicides formed by direct ion beam deposition.** Zuhr, R.A. (Solid State Div., Oak Ridge National Lab., Oak Ridge, TN (US)); Pennycook, S.J.; Haynes, T.E.; Holland, O.W. 47-54 of Processing and characterization of materials using ion beams. Rehn, L.E.; Greene, J.; Smidt, F.A. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-8811225–: Processing and characterization of materials using ion beams, Boston, MA (USA), 28 Nov - 2 dec 1988).

Thin films of transition metal silicides have been produced at low temperatures on Si substrates by direct ion beam deposition (IBD) of the metal ion. Using a mass-analyzed beam of metallic ions rastered over the target at energies on the order of 100eV and at substrate temperatures near 500°C, stoichiometric silicide films of varying thicknesses up to 300 nm have been formed on both n- and p-type Si. The advantages of this technique over other methods for silicide formation include good control of thickness by current integration, high purity due to the mass analysis, and control of incident ion energy which permits formation of the disilicide phase at low temperatures, thereby minimizing the thermal budget and the associated dopant diffusion in the underlying substrate. Films were characterized by Rutherford backscattering, transmission electron microscopy, and electrical measurements. Co, Fe, Ni, Ti, and W silicides have been formed by this direct deposition process. The effectiveness of the technique has been found to be dependent upon the diffusion characteristics of the particular metal/Si couple involved, with systems in which Si is the dominant diffuser, such as Ti/Si, giving the best results.

32628 **The influence of thickness and wavelength on the mechanical properties of a compositionally modulated ceramic thin film.** Oliver, W.C. (Metals and Ceramics Div., Oak Ridge National Lab., Oak Ridge, TN (US)); List, F.A.; McKee, R.A. 99-104 of Thin films. Bravman, J.C.; Nix, W.D.; Barnett, D.M.; Smith, D.A. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-8811222–: Thin films: stresses and mechanical properties, Boston, MA (USA), 28-30 Nov 1988).

The hardness and modulus of thin ($<1\mu m$) ceramic films have been investigated using the differential mechanical properties microprobe (DMPM). The DMPM consists of a computer controlled ultra-low load indentation system with a special system that allows the elastic stiffness of the contact to be determined continuously during the indentation process. The films were deposited in a molecular beam epitaxy (MBE) system utilizing unique high temperature effusion cells. Two specimens have been studied. The first is a wedge shaped layer of amorphous Al_2O_3 on a silicon substrate. The thickness of the layer varies from 0 to 990 nm at the two extreme sides of a 3 in. silicon wafer. The effect of layer thickness on the hardness and modulus as measured with the DMPM has been quantified for this system. The second specimen is made up of 38 repetitions of alternating layers of crystalline TiO_2 and amorphous Al_2O_3. The wavelength of the composition modulation and the thickness of the film varies uniformly from 0 to 38 nm and from 0 to 1460 nm respectively across the 3 in. diameter of the silicon substrate.

32629 **Radiographic imaging technologies for archaeological ceramics.** Ellingson, W.A. (Argonne National Lab., Argonne, IL (US)); Vandiver, P.B.; Robinson, T. K.; Lobick, J.J. 25-32 of Materials issues in art and archaeology. Sayre, E.V.; Vandiver, P.; Sruzik, J.; Stevenson, C. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract W-31-109-ENG-38. (CONF-8804301–: Materials issues in art and archaeology, Reno, NV (USA), 6-8 Apr 1988).

In archaeological studies of ceramic materials, nondestructive evaluation (NDE) methods are needed to better understand the nature and evolution of ceramic fabrication techniques and even to authenticate ancient ceramics. The desired data are similar to those sought in modern fine ceramics, especially advanced structural ceramics. X-ray imaging technologies, developed to characterize structural ceramics, were applied to three samples, a

modern and two archaeological ceramics, in order to obtain fabrication information. They were imaged using various x-ray image receivers: electrostatic receivers, photostimulable phosphors, and high-resolution industrial x-ray film. Ultrasound and dye penetrants had failed to reveal methods of manufacture in the ancient ceramics because of their highly porous fabric.

32630 **Ordering in $Tl_2CaBa_2Cu_2O_8$ and $Tl_2Ba_2CuO_6$ studied by pair distribution function and Rietveld analysis.** Toby, B.H. (Pennsylvania Univ., Philadelphia, PA (USA). Dept. of Materials Science and Engineering); Dmowski, W.; Egami, T.; Jorgensen, J.D.; Subramanian, M.A.; Gopalakrishnan, J.; Sleight, A.W.; Parise, J.B. 101-102 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The authors argue that rietveld analysis indicated that the only long-range structural variation in $Tl_2CaBa_2Cu_2O_8$ with temperature is a shift of O(2) away from Cu and toward Ba with increasing T. Atomic pair distribution function analysis on two samples of $Tl_2Ba_2CuO_6$, one superconducting, the other not, shows substantial differences in their short range structure, but similar medium range structures, while Rietveld analysis shows very similar lattice constants and long-range structures.

32631 **YBCO films on YSZ and Al_2O_3 by pulsed laser deposition.** Fork, D.K. (Stanford Univ., CA (USA). Dept. of Applied Physics); Geballe, T.H.; Bridges, F.; Boyce, J.B.; Connell, G.A.N.; Char, K.; Tahara, S.; Lairson, B. 121-122 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Thin films of the YBCO superconductor have been deposited on three oxide substrate by pulsed laser deposition. The authors report that the large lattice mismatch on yttria stabilized zirconia (YSZ) does not markedly degrade the film properties, including Jc. The lattice mismatch on Al_2O_3 does not degrade Tc or the normal state electrical conductivity.

32632 **Photoluminescence spectroscopy of thin indium-tin-oxide contracts on mercuric iodide substrates.** James, R.B. (Sandia National Lab., Theoretical Div., Livermore, CA (US)); Bao, X.J.; Schlesiner, T.E.; Markakis, J.M.; Cheng, A.Y.; Ortale, C. 103-112 of Fluorescence detection III. Menzel, E.R. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). (CONF-8901152–: 3. fluorescence detection, Los Angeles, CA (USA), 16-18 Jan 1989).

This paper reports on mercuric iodide (HgI_2) photodetectors with sputtered indium-tin-oxide (ITO) entrance electrodes studied using low-temperature photoluminescence spectroscopy. The photoluminescence spectra obtained on each photodetector was found to differ for points beneath the ITO contact and points adjacent to it, indicating that the contact fabrication process introduces new carrier traps and radiative recombination centers within the ITO-HgI_2 interfacial region. In particular, a new broad band was observed in the spectra taken from points beneath the ITO electrode. Photocurrent-versus-position measurements showed that the intensity of this broad band was enhanced in regions having relatively poor photoresponse. Specimens of HgI_2 with evaporated semitransparent tin and indium films were also investigated. The spectra obtained from points beneath the Sn and In films suggest that the regions having poor photoresponse in the ITO-contacted photodetector contain either free tin or indium metal.

32633 **Superconductivity and magnetism in $La_2CuO_{4+\delta}$ by μSR.** Ansaldo, E.J. (Saskatchewan Univ., Saskatoon, SK (Canada). Dept. of Physics); Brewer, J.H.; Riseman, T.M.; Schirber, J.E.; Venturini, E.L.; Morosin, B.; Ginely, D.S.; Sternlieb, B. 147-148 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The authors report that the two phase constitution $La_2CuO_{4+\delta}$ have been determined and studied in a series of redundant spin rotation and relaxation measurements in transverse and zero external fields. 60% of the sample volume was found to be superconducting with penetration depth λ (0) = 4200 A (powder average). The other phase displayed similar magnetic ordering to that of La_2CuO_4.

32634 **High-resolution microscopy of ceramics.** Carter, C.B. (Dept. of Materials Science and Engineering, Cornell Univ., Ithaca, NY (US)); McKernan, S.; Rasmussen, D.R.; Simpson, Y.K.; Summerfelt, S.R.; Susnitzky, D.W.; Tietz, L.A. 189-198 of High resolution microscopy of materials. Krakow, W.; Ponce, F.A.; Smith, D.J. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811196–: MRS symposium on high resolution microscopy of materials, Boston, MA (USA), 29 Nov - 1 dec 1988).

The use of high-resolution electron microscopy in the study of ceramic materials is illustrated with examples from current research. Particular emphasis is placed on the preparation of the sample and the difficulties in interpretation which may result from the techniques which are necessary for these hard, chemically inert materials.

32635 **Characterization of $KNbO_3$ thin films deposited by ion beam sputtering using a computer-controlled rotating target holder.** Ameen, M.S. (North Carolina State Univ., Materials Science and Engineering, Raleigh, NC (US)); Graettinger, T.M.; Rou, S.H.; Kingon, A.I.; Krauss, A.R.; Auciello, O. 175-182 of Optical materials. Poker, D.B.; Ortiz, C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8904283–: Optical materials: processing and science, San Diego, CA (USA), 24-26 Apr 1989).

$KNbO_3$ is a strong candidate as a material for use as channel waveguides due to a high electrooptic figure of merit. High quality single crystals are difficult to obtain due to incongruent melting of the compound. Control of cation concentration and oxygen incorporation are problems encountered in current thin film processing routes. In order to overcome the problems discussed above, an ion beam deposition system featuring a computer-controlled rotatable target holder and quartz crystal resonator (QCR) feedback loop has been developed. Multicomponent films are produced via sputtering from elemental or compound targets sequentially exposed to an ion beam. Initial results are presented on the use of this new technique for the deposition of $KNbO_3$. Pressed $KNbO_3$, Nb_2O_5, and KO_2 powders were used as sputtering targets. By varying the programmed thickness of deposited film from each target being sputtered, the ration of K:Nb could be reproducibly controlled. The variation in sticking coefficients due to substrate temperature was also compensated for in this manner.

32636 **δ^2 – $Y_2Si_2O_7$ structure confirmed by processing and simulaton of atomic-resolution images.** Rai, R.S. (Dept. of Ceramic Engineering, Ohio State Univ., Columbus, OH (US)); O'Keefe, M.A.; Thomas, G. 175-180 of High resolution microscopy of materials. Krakow, W.; Ponce, F.A.; Smith, D.J. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC03-76SF00098. (CONF-8811196–: MRS symposium on high resolution microscopy of materials, Boston, MA (USA), 29 Nov - 1 dec 1988).

High resolution electron micrographs have been obtained in various orientations for δ_2-$Y_2Si_2O_7$ using the atomic resolution microscope (ARM) at the National Center for Electron Microscopy (NCEM). These ARM images were processed by masking the diffractogram of the digitized image in Fourier space and applying an inverse transform (using the SEMPER program at the NCEM Image Analysis Facility) in order to reveal details obscured by amorphous contrast originating in the glassy matrix. Processed experimental images from very thin regions of the crystalline phase are compared with images simulated from postulated models (SHRLI images). Close agreement is obtained.

32637 Microanalytical and structural characterization of optical materials by electron microscopy and related spectroscopies. Krishnan, K.M. (National Center for Electron Microscopy, Materials and Chemical Sciences Division, Lawrence Berkeley Lab., Berkeley, CA (US)). 151-162 of Optical materials. Poker, D.B.; Ortiz, C. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC03-76SF00098. (CONF-8904283--: Optical materials: processing and science, San Diego, CA (USA), 24-26 Apr 1989).

The fine probe forming capabilities of an analytical electron microscope combined with the development of related spectroscopies, diffraction and imaging techniques, makes it possible to obtain structural and chemical information from multiphase materials at high spatial resolution. These microanalytical methods are described with relevant examples from our studies of compounds in the Al_2O_3-AlN pseudo binary system, a potential window material, low-pressure synthesized diamond, diamond-like carbon and hydrocarbon films. A comprehensive example of the characterization of a novel AlON polytypoid structure (32H), level of resolution and the need to employ all the complementary methods of analysis, is discussed. Efforts to characterize a variety of diamond-like carbon films by the measurements of both the low-loss plasmon resonances and the fine structure in the core-loss edges observable in the energy-loss spectrum, to obtain sp_3/sp_2 ratios are outlined. The electronic structure of thin film diamonds, synthesized by a plasma enhanced chemical vapor deposition method, has been shown to be in agreement with band structure calculations.

32638 Laser studies of the SiH radical/surface interaction during deposition of a thin film. Ho, P. (Sandia National Lab, Albuquerque, NM (US)); Buss, R.J.; Breiland, W.G. 233-238 of Chemical perspectives of microelectronic materials. Gross, M.E.; Jasinski, J.M.; Yates, J.T. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC04-76DP00789. (CONF-8811223--: Chemical perspectives of microelectronic materials, Boston, MA (USA), 30 Nov - 2 dec 1988).

This paper presents a method for studying the interaction of radicals with the surface of a depositing film using a combination of laser spectroscopy and molecular beam techniques. The reactivity of SiH molecules with the surface of a depositing a-Si:H film is measured to be at least 0.95, with no strong dependence on rotational state.

32639 Catalytic oxidation of silicon nitride thin films using potassium. Rogers, J.W. (Sandia National Lab, Albuquerque, NM (US)); Blair, D.S.; Peden, C.H.F. 223-225 of Chemical perspectives of microelectronic materials. Gross, M.E.; Jasinski, J.M.; Yates, J.T. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC04-76DP00789. (CONF-8811223--: Chemical perspectives of microelectronic materials, Boston, MA (USA), 30 Nov - 2 dec 1988).

This paper reports thin silicon nitride films on a Si(100) substrate oxidized using potassium in a low thermal budget process. The presence of potassium on the Si_3N_4 surface greatly lowers the temperature-time requirements for oxidation as compared with direct thermal oxidation.

32640 Calculation of the nuclear quadrupole resonance spectra of $YBa_2Cu_3O_{7-x}$. Winter, N.W. (Lawrence Livermore National Lab., CA (USA)); Violet, C.E. 261-262 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718--: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Nuclear quadrupole resonance (NQR) and nuclear magnetic resonance (NMR) studies on $^{63,65}Cu$ have demonstrated that the resonance properties of these nuclei can give important information about the electronic structure of the high temperature superconductor $YBa_2Cu_3O_{7-x}$ as well as the exchange coupling energy between the Cu(2) sites. Measurements for various oxygen stoichiometries have given insight into the effect of oxygen content on the valence state of the Cu. In the work reported here, the electric field gradient (EFG) tensors at the Cu(91) and Cu(2) sites in YBa(sub 2)Cu_3O_{7-ax}, have been determined from calculations on large clusters for x-0 and 1. The results were found to be sensitive to the nature of the chemical bonding a the Cu sites and indicate the point-charge models which neglect the valence electron contributions will not accurately describe the EFG. Good agreement with experiment is obtained only if the multi-valent character of the Cu ions was included in the wave function by configuration interaction.

32641 Magnetism, specific heat, and pressure-dependent resistivity of the electron-doped compounds LnMCuO(Ln = Pr,Nd,Sm,Eu,Gd:M = Ce,Th). Maple, M.B. (California Univ., San Diego, La Jolla, CA (USA). Dept. of Physics); Ayuub, N.Y.; Bi0rnholm, T.; Early, E.A.; Ghamaty, S.; Lee, B.W.; Markert, J.T.; Neumeier, J.J.; Seaman, C.L. 296-299 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718--: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Measurement of the magnetic susceptibility χ, the specific heat C, and the electrical resistivity ρ are presented for the Nd_2CuO_4 type structure insulating parent compounds Ln_2CuO_4 (ln = Pr, Nd,SM,EU,and GD), the doped superconducting compounds $Ln_{2-x}M_xCuO_{4-y}$ (ln = Pr, Nd,Sm and Eu, M = Ce; Ln = Pr and Nd, M = Th), and the doped semiconducting compound $Gd_{2-x}CE_xCuO_{4-y}$. The χ and C data indicate that antiferromagnetic (AFM) order occurs in the undoped compounds for Ln - Nd, Sm and Gd at temperatures below 1.7K, 5.90:0095K and 6.6K respectively. The coexistence of superconductivity and AFM order is observed in $Ln_{1.85}M_{0.15}CuO_{4-y}$, with reduced Neel temperatures T_N= 1.2K for Ln = Nd, M = Ce, Th and T_N = 4.6K for Ln = Sm, M = Ce. Magnetic susceptibility data from $Gd_{2-x}CE_xCuO_{4-y}$ display evidence from ARM ordering of Cu^{2+} spins at 280K for X = 0 and at 150K for x = 0.15. For $Nd_{1.85}M_{0.15}CuO_{4-y}$, a very slight increase (decrease) in T_c with applied pressure is observed for M = Ce(Th); this relative insensitivity and the depression of T_c for M = Th is in contract to the behavior observed for other high T_c compounds.

32642 Nitrogen doping of ZnO prepared by organometallic chemical vapor deposition. Pan, H.C. (Dept. of Materials Science and Engineering, Northwestern Univ., Evanston, IL (US)); Wessels, B.W. 215-220 of Optical materials. Poker, D.B.; Ortiz, C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8904283--: Optical materials: processing and science, San Diego, CA (USA), 24-26 Apr 1989).

ZnO layers were grown by organometallic chemical vapor deposition. Films were deliberately doped with nitrogen by incorporating ammonia into the ambient during growth. The resistivity of the films depended strongly on the ammonia partial pressure. The layers were n-type with resistivities in the range of 0.1 - 360 ohm-cm. The films exhibited strong ultraviolet nearbandedge photoluminescent emission. Emission was ascribed to recombination of bound excitons at neutral acceptors, presumably involving substitutional nitrogen.

32643 Calculation of ion channeling directions in low symmetry optical materials. Poker, D.B. (Solid State Div., Oak Ridge National Lab., Oak Ridge, TN (US)). 291-294 of Optical materials. Poker, D.B.; Ortiz, C. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-8904283--: Optical materials: processing and science, San Diego, CA (USA), 24-26 Apr 1989).

Rutherford backscattering spectroscopy along ion channeling directions is useful for numerous applications in the characterization of all types of materials, due to its sensitivity to interstitial location, lattice quality, and composition. The determination of channeling directions and sample orientation in materials with high symmetry lattices is usually straightforward. However, many optical materials have relatively low crystal symmetry, which complicates the determination of likely directions for ion channeling. This is especially true of electrooptic materials, such as $LiNbO_3$, which lack inversion symmetry. Therefore, an algorithm for the calculation of likely channeling directions in low symmetry lattices has been developed

and is presented in this paper. The algorithm creates a virtual three-dimensional atomic structure from lattice and basis data input by the user. The size of atoms within the lattice can be varied to represent relative ion scattering cross sections. The optical transmission of the structure in the hard sphere approximation is calculated for an array of angular orientations. A stereographic projection of the data can be used to display the relative channeling probabilities of the crystal. The correlation between optical transmission and channeling yield, and the application of the algorithm to planar as well as axial channeling is discussed.

32644 Preparation, fabrication and properties of a rare earth intermetallic compound - GdPd. Beaudry, B.J. (Ames Lab., Iowa State Univ., Ames, IA (US)); Tang, J. 237-242 of Rare earths: Extraction preparation and applications. Bautista, R.G.; Wong, M.M. The Metallurgical Society Inc., Warrendale, PA (USA) (1988). DOE Contract W-7405-ENG-82. (CONF-890251–: Rare earth conference: extraction preparation and applications meeting, Las Vegas, NV (USA), 27 Feb - 2 mar 1989).

Intermetallic compounds are frequently required in the form of thin sheets for magnetic refrigeration and other applications. Progress has been made in the preparation of thin sheets of brittle gadolinium intermetallic compounds by hot rolling of sheathed billets. The effect of fabrication procedures on the Curie temperature of GdPd and its heat capacity at low temperatures is studied.

32645 Phases and microstructures of carbon-implanted niobium. Huang, J.S. (Lawrence Livermore National Lab., Livermore, CA (US)); Musket, R.G.; Wall, M.A. 327-332 of Processing and characterization of materials using ion beams. Rehn, L.E.; Greene, J.; Smidt, F.A. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-8811225–: Processing and characterization of materials using ion beams, Boston, MA (USA), 28 Nov - 2 dec 1988).

Polycrystalline niobium was implanted with 200, 100, and 50 keV carbon ions to create a uniform distribution of carbon over a thickness of about 0.25 μm. Samples implanted with calculated carbon content of 0.6, 1.9, 5.8, and 16 atomic percent were prepared, and the uniformity of the carbon distribution with depth was confirmed by Auger electron spectroscopy analysis. Glancing-angle X-ray diffraction analysis and transmission electron microscopy were used to characterize the phases and microstructures formed. The results indicate that no detectable second phases were present except on the surfaces where an amorphous phase and many particles were formed from contamination. Despite the low equilibrium solubility limit of carbon in Nb, the authors have created metastable solid solutions of Nb and C with carbon contents as high as 16 at.%.

32646 Magnetic and pairing correlations in a three band Hubbard model. Scalettar, R.T. 313-316 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The two dimensional CuO_2 sheets common to both the superconducting oxides $La_{1-x}Sr_xCuO_4$ and $YBa_2Cu_3O_{7-\delta}$ are believed to play an important role in the high transition temperatures of these materials. In this paper, the authors make use of some recently developed techniques for the simulation of systems of strongly interacting electrons at low temperatures to study a multiband positive-U Hubbard model. As in the single band model, doping away from one hole per unit cell rapidly decreases antiferromagnetic correlations. In contrast to the single band model, enhancement of the extended s-wave pairing susceptibility is a feature of a number of regimes of interaction strengths.

32647 Interlayer coupling in high temperature superconductors. Malozemoff, A.P. (IBM Research Div., Yorktown Heights, NY (USA)); Krusin-Elbaum, L.; Clem, J.R. 353-354 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The authors consider the high temperature superconductors such as YBaCuO as a stack of planar superconductors. The interlayer Josephson coupling deduced from the perpendicular penetration depth is of order 10^{8} A/cm^{2} for YBaCuO and B1SrCaCuO crystals indicates clean limit behavior for in-plane supercurrents but dirty limit behavior for perpendicular supercurrents. The much lower values of transport critical current density J_c reported so far are understood in terms of weak pinning for the interplanar vortices as they slide between the planes.

32648 Microstructural characterization of Al_2O_3 following simultaneous triple ion bombardment. Zinkle, S.J. (Oak Ridge National Lab., Oak Ridge, TN (US)). 363-368 of Processing and characterization of materials using ion beams. Rehn, L.E.; Greene, J.; Smidt, F.A. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-8811225–: Processing and characterization of materials using ion beams, Boston, MA (USA), 28 Nov - 2 dec 1988).

The through-range microstructure of polycrystalline alumina has been examined by cross-section TEM following simultaneous implantation of 2.0 MeV Al^+, and 0.2 to 0.4 MeV He^+ ions at room temperature to a dose of 3.1 keV/atom. The specimen remained crystalline following the irradiation, and four distinct radiation-induced defect features were observed:network dislocations, dislocation loops, small cavities, and oblong clusters that may be aluminum colloids. The microstructure near the implanted ion region was qualitatively similar to that observed in irradiated regions far from the implanted zone.

32649 Unlubricated sliding properties of ion beam and excimer laser mixed Fe-Ti-C multilayered films. Hirvonen, J.P. (Materials Science and Technology Div., Los Alamos National Lab., Los Alamos, NM (US)); Nastasi, M.; Jervis, T.R.; Tesmer, J.R.; Zocco, T.G. 451-456 of Processing and characterization of materials using ion beams. Rehn, L.E.; Greene, J.; Smidt, F.A. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811225–: Processing and characterization of materials using ion beams, Boston, MA (USA), 28 Nov - 2 dec 1988).

This paper reports multilayered Fe-Ti-C films consisting of eleven sublayers vacuum deposited onto an AISI 304 stainless steel substrate and subsequently mixed using either 400 keV Xe ions or an excimer laser operating at a wavelength of 308 nm. Ion mixing was accomplished in a two step process:the multilayers were first irradiated with 1×10^{17} Xe/cm^2 at 520°C, after which half of the sample was irradiated with 5×10^{15} Xe/cm^2 at 0°C. Laser mixing was carried out at both 1.1 and 1.7 J/cm^2 with the number of pulses varied between 1 and 10. Pin-on-disc studies revealed only slight differences between the two kinds of ion beam mixed samples, whereas the dry sliding properties of laser mixed samples were strongly dependent on the total fluence used. In the optimum conditions, similar friction coefficients were obtained on both kinds of samples.

32650 Effects of deformation on shielding currents in $YBa_2Cu_3O_{7-\delta}$. Kramer, M.J. (Ames Lab., Iowa State Univ., Iowa State Univ., Ames, IA (US)); McCallum, R.W.; Chumbley, L.S. 552-553 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-7405-ENG-82. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Magnetization data from magnetically aligned deformed $YBa_2Cu_3O_{7-\delta}$ powder shows that the superconducting currents are disrupted in the ab plane by intracrystalline fractures and in the c-axis direction by dislocation arrays. Upon re-sintering at 900°C, the dislocation arrays are replaced by stacking faults which do not disrupt the superconducting currents.

32651 Preparation and characterization of single phase $Ba_{1-x3}K_xBIO_3$. Folkerts, T.J. (Dept. of Physics, Univ. of California, Davis, CA (US)); Shelton, R.N.; Radousky, H.B. 550-551 of

Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

High quality single phase samples of $Ba_{1-x}K_xBiO_3$ (BKBO) have been made across the range of compositions from $0<x<0.5$. Powder x-ray diffraction data indicates pure single phase materials for all potassium concentrations. Samples with $x<0.35$ are nonsuperconducting while those with $x>0.35$ show sharp superconducting transitions from both resistivity and magnetization measurements. Care during sample preparation is vital for obtaining quality samples of this material.

32652 **The chevron-notched bend bar technique for fracture resistance measurements of ceramics.** Ghosh, A. (College of Engineering, Univ. of Washington, Seattle, WA (US)); Kobayashi, A.S.; Bradt, R.C.; Jenkins, M.G.; White, K.W. 592-603 of Proceedings of the third international symposium on ceramic materials. Tennery, V.J. American Ceramic Society Inc., Columbus, OH (USA) (1989). (CONF-881125–: 3. international symposium on ceramic materials and components for engines, Las Vegas, NV (USA), 27-30 Nov 1988).

Application of the chevron-notched bend bar specimen to the measurement of the fracture resistance of ceramics is described. The specimen and technique have the advantages that fracture toughness values, complete crack growth resistance, or R-curves and the work-of-fracture can all be readily obtained from a single test specimen. Furthermore, the method is easily applied to specimens at elevated temperatures, readily adapting to the noncontract LISG monitoring system. Measurements of a dense sintered SiC utilizing the technique are compared with results from other techniques and specimens.

32653 **Comparison between $LaGaO_3$, $LaAlO_3$,$KTaO_3$ and $SrTiO_3$ substrates for the epitaxial growth of $YBa_2Cu_3O_{7-x}$ thin films by a BaF_2 process.** Feenstra, R. (Solid State Div., Oak Ridge National Lab., Oak Ridge, TN (US)); Budai, J.D.; Galloway, M.D.; Boatner, L.A. 655-656 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract AC05-84OR21400. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

This paper reports $YBa_2Cu_3O_{7-x}$ films with thicknesses in the range 60–320 nm grown on $LaGaO_3$, $LaAlO_3$, $KTaO_3$, and $SrTiO_3$ single-crystal substrates by coevaporation of Y, Cu, and BaF_2 followed by annealing at 850°C in wet oxygen. Films formed with a thickness of 160 nm or greater on $SrTiO_3$, $KTaO_3$, and $LaGaO_3$ exhibited sharp superconducting transitions near T_c= 91 K. For films on $LaAlO_3$, $T_c$was typically reduced by 6–8 K. For films with a thickness less than 120 nm, the superconducting transition broadens for every film-substrate combination investigated, and $T_c$shifts to lower temperatures with decreasing film thickness.

32654 **Flux-flow resistivity in single crystal $YBa_2Cu_3O_{7-\delta}$.** Kwok, W.K. (Materials Science Div., Argonne National Lab., Argonne, IL (US)); Welp, U.; Crabtree, G.W.; Vandervoort, K.G.; Liu, J.Z. 669-670 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-31-109-ENG-38. Grant STC-8809854. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

AC magnetoresistance measurements were performed on a single crystal of $YBa_2Cu_3O_{7-\delta}$ in order to study the effect of dissipative flux flow motion due to Lorentz force. The authors find the shape of the superconducting resistive transition curve in field to vary with the Lorentz force but the zero resistance temperature to be independent of flux motion.

32655 **Temperature dependence of the lower critical field of single crystal $YBa_2Cu_3O_{7-\delta}$.** Umezawa, A (Materials Science Div, Argonne National Lab, Argonne IL (US)); Crabtree, G.W.; Vandervoort, K.G.; Welp, U.; Kwok, W.K; Liu, J.Z. 733-734 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-31-109-ENG-38. Contract STC-8809854. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

This paper reports H_c1 vs T measured from the magnetization curves for H//ab. $H_c1(T)$ near T_c follows an empirical form but does not saturate at low temperatures.

32656 **Observation of thermally activated flux motion in weak link structures.** Maley, M.P. (Los Alamos National Lab., Los Alamos, NM (US)); McHenry, M.E.; Willis, J.O.; McElfresh, M. 701-702 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The authors have measured the time rate of magnetic flux motion through an array of weak links present in the wall of a hollow cylinder of ceramic $YBa_2Cu_3O_7$. They observe a logarithmic time dependence of the magnetic field in the center of the tube with an applied field of 28 Oe at 75 K. Analysis of the logarithmic creep rate with a standard phenomenological model yields an activation energy of $\sim$ 1.55 eV for the motion of Josephson ortices through the weak links in the structure.

32657 **Ion implantation and ion beam analysis of lithium niobate.** Arnold, G.W. (Sandia National Lab., Ion-Solid Interactions Div., Albuquerque, NM (US)). 713-716 of Processing and characterization of materials using ion beams. Rehn, L.E.; Greene, J.; Smidt, F.A. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC04-76DP00789. (CONF-8811225–: Processing and characterization of materials using ion beams, Boston, MA (USA), 28 Nov - 2 dec 1988).

This paper reports on implantations of He and Ti made into $LiNbO_3$ and the H and Li profiles determined by elastic recoil detection (ERD) techniques. The loss of Li and gain of H depends upon the supply of surface H (surface contaminants or ambient atmosphere). For 50 KeV He implants into $LiNbO_3$ through a 200 Å Al film, the small Li loss is governed by the interface H. This is also the case for He implants into uncoated $LiNbO_3$ in a beam line with low hydrocarbon surface contamination; similar implants under conditions of greater hydrocarbon deposition result in proportionally larger Li loss and H gain in the implant damage region. The exchange is possible only for those He energies, i.e., 50 keV, where the damage profile intersects the surface. For Ti implants Li is lost with little H gain. For this case the Li loss is believed to result from radiation-enhanced diffusion. Where He implantation is used to establish waveguiding in $LiNbO_3$, the presence or absence of H in the implanted region is crucial with regard to refractive index stability, due to the replacement of H by Li from the bulk.

32658 **17_{ONMR} study of $YBa_2Cu_3O_{7-\delta}$.** Takigawa, M (Los Alamos National Lab., Los Alamos, NM (US)); Hammel, P.C.; Heffner, R.H.; Fisk, Z; Ott, K.C.; Thompson, J.D. 853-856 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The authors present ^{17}O NMR experimental results in a magnetically aligned powder sample of $YBa_2Cu_3O_{7-\delta}$ (T_c = 93 K). The sign of the anisotropic Knight shift shows that the spin density resides mainly on the p_{sigma} orbitals at the planar O(2,3) and bridging o(4) sites. About 30% of the total spin susceptibility is attributed

to the oxygen $2p_\sigma$ states. The knight shift at the O(2,3) sites decreases more rapidly than that at the chain O(1) sites, indicating a larger gap in the planes. The nuclear relaxation rate at the O(2,3) sites shows linear-T (Korringa) behavior above T_c, in contrast to the much weaker temperature dependence at the planar Cu(2) sites. However, these two rates show identical temperature dependence below about 110 K, indicating that an important change in the spin dynamics takes place above T_c.

32659 Neutron scattering studies of magnetic correlations in the layered cuprates. Tranquada, J.M (Physics Dept., Brookhaven National Lab., Upton, NY (US)); Shirane, G. 849-852 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract AC02-76CH00016. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

All of the copper oxide superconductors contain CuO_2 layers which, when insulating, exhibit strong two dimensional (2D) antiferromagnetic correlations due to the unusually large superexchange interaction between nearest-neighbor Cu^{2+} atoms. Magnetic correlations survive, although with a reduced correlation length, even when the layers are doped with holes. A review of neutron scattering studies of magnetic correlations and excitations in the layered cuprates is presented.

32660 Superconducting properties of grain boundaries in dense, fine grained $YBa_2Cu_3O_x$. McCallum, R.W. (Ames Lab., Iowa State Univ., Ames, IA (US)); Arrasmith, S.R.; Dennis, K.W.; Kramer, M.J. 933-934 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-7405-ENG-82. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

$YBa_2Cu_3O_x$ samples have been produced in the form of uniform spheres 50 to 100 μm in diameter. The grain size within the spheres may be varied by appropriate annealing over the range of 1-2 μm up to the sphere diameter. This paper reports the superconducting properties of fine grained spheres (1.7 and 2.0 μm) investigated using low field DC magnetization measurements. The critical current of the grain boundary is found to be significantly larger for the 1.7 μm material than the 2μm material.

32661 Hall effect measurements in thin films of $Tl_2Ba_2CaCu_2O_x$. Woo, K.C. (Materials Science Div., Argonne National Lab., Argonne, IL. (US)); Gray, K.E.; Kampwirth, R.T.; Kang, J.H. 1011-1012 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-31109-ENG-38. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Hall effect measurements are one of the primary methods for determining the sign and magnitude of the carrier density in the high-temperature superconductors. Although for $La_{2-x}Sr_xCuO_4$, $YBa_2Cu_3O_7$ and $Bi_2Sr_2CaCu_2O_x$, the positive Hall coefficients predict hole conduction, $Nd_{2-x}Ce_xCuO_4$ has been reported to be an electron-doped superconductor based on Hall and Seebeck measurements. The authors present results for sputtered thin films of $Tl_2Ba_2CaCu_2O_x$. They are substantially similar to the former, indicating this material also exhibits hole conduction.

32662 Phenomenological theory of magnetic structure in the high-temperature superconductors. Clem, J.R. (Ames Lab.-USDOE and Dept. of Physics, Iowa State Univ., Ames, IA (US)). 1137-1142 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-7405-ENG-82. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

In the absence of a complete microscopic theory of the high-temperature copper-oxide superconductors, several phenomenological theoretical approaches are being used to describe the intragranular magnetic structure in the mixed state. This paper reviews these approaches and points out where further developments are needed.

32663 Local oxygen configurations relative to $F_e$probe ions in $HoBa_2Cu_{0.95}{}^{Fe}{}_{0.053}{}^{0}{}_{7-x}$. Violet, C.E. (Lawrence Livermore National Lab., Livermore, CA (US)); Bedford, R.G.; Hahn, P.A.; Winter, N.W.; Mei, Z. 1291-1292 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The authors have measured ^{57}Fe Mossbauer spectra at room temperature for $HoBa_2Cu_{0.95}Fe_{0.053}O_{7-x}$over a range of oxygen deficiency, x, in order to observe the effect of oxygen stoichiometry on local oxygen configurations relative to the Cu substituted Fe-probe ions. Oxygen stoichiometry ($O < x < 1.407$) was established by thermogravimetry using a Perkin-Elmer System 7 thermogravimetric analyzer with a standard furnace. Samples in a platinum pan were heated in oxygen to 950°C and cooled at 2° per minute to 30°C in order to establish a well characterized initial state assumed to be $HoBa_2(Cu_{0.95}Fe_{0.05})_3O_{7.0}$. Substoichiometric samples were then prepared by heating the fully oxidized material to temperatures in the range 500° to 900°C under nitrogen or argon, holding isothermally for an appropriate time to achieve the desired weight loss and cooling at 2° per minute. Based on x-ray diffraction analysis the $x = 1.07$ sample is Ho_2BaCuO_5 (green phase). All other samples are the tetragonal phase of $HoBa_2(Cu_{0.95}Fe_{0.05})_3O_{7-x}$. The Tc for $x \sim 0.05$ is 48K.

32664 Microwave surface impedance of granular superconductors. Portis, A.M. (Univ. of California at Berkeley, CA (US)); Cooke, D.W.; Piel, H. 1547-1548 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Microwave surface impedance studies of bulk and film cuprate superconductors are modeled by an intergranular medium that is characterized by an inductor L and a shunt resistor R. Below the crossover frequence $gom_x = R/L$, the surface resistance R_s increases as gom^2 and at frequencies above gom_x and $gom^{1/2}$. Measurements of R_s and estimates of R for high quality epitaxial films, indicate that gom_x is in the infrared. The surface resistance R_s has been measured as a function of microwave power in bulk ceramics and in films. These studies indicate that R_s is finite at arbitrarily low microwave power. Increases in R_s with power are associated with the development of an intergranular critical state of microwave flux.

32665 Radiation effects in magnetic and superconducting materials. Brown, R.D. (Los Alamos National Lab., NM (USA)); Cost, J.R. *Journal of Metals (USA)*, 42(2): 39-43 (Feb 1990).

Many of the newly developed materials, such as rare-earth permanent magnets, amorphous alloys and oxide superconductors, have important applications in radiation environments. These environments can have various negative or beneficial effects on the properties, depending on the amount of radiation and the nature of material. The authors discuss how properties such as the critical current in superconductors can actually be increased by radiation, while critical temperature is decreased. More detailed study of the mechanisms responsible for such radiation-induced changes may

lead to material with greater stability in these challenging environments.

32666 The production of high performance $YBa_2Cu_3O_7$ using nitrogen dioxide. Leary, K.J. (Chemicals & Pigments Department, E. I. duPont de Nemours & Co., Inc., Wilmington, Delaware 19880-0304 (US)); Jacobson, H.W.; Levoy, N.F.; Lapalomento, R.A.; Askew, T.R.; Flippen, R.B.; Keller, S.W. *Journal of Materials Research (USA)*, 5(1): 22-26 (Jan 1990). DOE Contract AC03-76SF00098.

Energy dispersive x-ray spectroscopy (EDS) was used to show that the elemental homogeneity of $YBa_2Cu_3O_7$ powders can be improved substantially by heating the powder in a nitrogen dioxide-containing atmosphere (e.g., 950 °C), followed by annealing in oxygen at 950 °C, and slow-cooling to room temperature. The improved homogeneity results in a substantially larger flux exclusion signal for the NO_2-treated powder, as measured by both ac and dc techniques. The experimental results suggest a mechanism which involves the formation of a small amount of molten $Ba(NO_3)_2$, which acts as a flux that dissolves the constituents and reprecipitates them as high purity $YBa_2Cu_3O_7$.

32667 High-pressure phase transitions in the 6H perovskites $Ba_3MSb_2O_9$ (M = Mg, Ni, Zn). Battle, P.D. (Leeds Univ. (England)); Jones, C.W.; Lightfoot, P.; Strange, R. *Journal of Solid State Chemistry (USA)*, 85(1): 144-150 (Mar 1990).

The 6H perovskites $Ba_3MSb_2O_9$ (M = Mg, Ni, Zn) have been subjected to pressures of up to 5.5 GPa. No structural phase transitions were observed in $Ba_3MgSb_2O_9$. $Ba_3NiSb_2O_9$ transformed from a phase containing Sb_2O_9 dimers formed by face-sharing octahedra into a phase containing $NiSbO_9$ dimers. This was confirmed by a combination of x-ray powder diffraction and EXAFS. $Ba_3ZnSb_2O_9$ transformed into a cubic perovskite with a partial ordering of zinc and antimony over the octahedral sites.

32668 Microencapsulation of silicon nitride particles with yttria and yttria-alumina precursors. Garg, A.K. (Center for Advanced Materials, Materials, Lawrence Berkeley Laboratory, Berkeley, California 94720 (USA)); De Jonghe, L.C. *Journal of Materials Research (USA)*, 5(1): 136-142 (Jan 1990). DOE Contract AC03-76SF00098.

Procedures are described to deposit uniform layers of yttria and yttria-alumina precursors on fine powders and whiskers of silicon nitride. The coatings were produced by aging at elevated temperatures aqueous systems containing the silicon nitride core particles, yttrium and aluminum nitrates, and urea. Optimum concentrations of the core particles, in relation to the reactants, were established to promote surface deposition of the oxide precursors. Polymeric dispersants were used effectively to prevent agglomeration of the solids during the microencapsulation process. The morphology of the powders was characterized using scanning and transmission electron microscopy. The mechanisms for the formation of the coated layers are discussed. A description is provided that allows qualitative assessment of the experimental factors that determine microencapsulation by a slurry method.

32669 High-temperature defect structure of Nb-doped $LaCrO_3$. Yu, Chikung J. (Univ. of Missouri, Rolla (USA)); Anderson, H.U.; Sparlin, D.M. *Journal of Solid State Chemistry (USA)*, 78(2): 242-249 (Feb 1989).

Electrical conductivity and Seebeck measurements on $LaCr^{0.98}Nb_{0.02}CrO_3$ show that the defect structure of the material is mainly controlled by the extrinsic electrons formed by the Nb donors through the electronic compensation process. The experimental results also indicate that this material conducts electricity via a small polaron mechanism with an electron mobility around 0.004-0.01 cm^2/v sec between 1100 and 1300°C. 8 refs., 10 figs.

32670 Upper critical field of a $Sm_{1.85}Ce_{0.15}CuO_{4-y}$ single crystal: interaction between superconductivity and antiferromagnetic order in copper oxides. Dalichaouch, Y. (Department of Physics and Institute for Pure and Applied Physical Sciences, University of California, San Diego, La Jolla, California 92093 (US)); Lee, B.W.; Seaman, C.L.; Markert, J.T.; Maple, M.B. *Physical Review Letters (USA)*, 64(5): 599-602 (29 Jan 1990). DOE Contract FG03-86ER45230.

The temperature dependence of the anisotropic upper critical magnetic field, $H_{c2}(T)$, has been determined resistively in antiferromagnetic $Sm_{1.85}Ce_{0.15}CuO_{4-y}$ single crystals. We observe the first evidence in high-T_c copper oxides for the interaction between superconductivity and antiferromagnetic ordering of rare-earth ions; estimates of the exchange coupling $J \approx 0.1$ eV and the Ginzburg-Landau coherence lengths $\xi_{ab}=79$ A and $\xi_c=14.7$ A are obtained. In both $Nd_{1.84}Ce_{0.16}CuO_{4-y}$ and $Sm_{1.85}Ce_{0.15}CuO_{4-y}$, the H_{c2} data above T_N can be described by $H_{c2}(T)/H_{c2}^{+}(0)=(1-T/T_c)^{1.6}$.

32671 Polymers, fractals, and ceramic materials. Schaefer, D.W. (Sandia National Labs., Albuquerque, NM (USA)). *Science (Washington, D.C.) (USA)*, 243(4894): 1023-1027 (24 Feb 1989). DOE Contract AC04-76DP00789.

Concepts borrowed from polymer science have been applied to tailor the properties of inorganic materials, especially those derived from amorphous precursors. Fractal geometry can be used to characterize macromolecular precursors and to relate their structures to kinetic growth processes. Within the silica system, for example, it is possible to manipulate the conditions of solution polymerization to yield a variety of macromolecules from branched chains to smooth colloidal particles. 34 refs., 6 figs.

32672 Epitaxial growth of diamond films on Si(111) at room temperature by mass-selected low-energy C^+ beams. Robertson, J.L. (Univ. of Houston, TX (USA)); Moss, S.C.; Lifshitz, Y.; Kasi, S.R.; Rabalais, J.W.; Lempert, G.D.; Rapoport, E. *Science (Washington, D.C.) (USA)*, 243(4894): 1047-1050 (24 Feb 1989).

Diamond films (≈ 0.7 micrometer thick) have been epitaxially grown on Si(111) substrates at room temperature with mass-selected 120-electrovolt C^+ ions. The diamond reflections observed in x-ray diffraction are well localized at their predicted positions, indicating that (i) the diamond(111) and (220) planes are parallel to the Si(111) and (220), respectively; (ii) the diamond rotational spread around its (110) normal is ≈ 1.7°; and (iii) the mosaic block size is ≈ 150 Å. The film growth is discussed in terms of subplantation - a shallow subsurface implantation model. This discovery is an important step toward diamond semiconductor devices. 26 refs., 4 figs., 1 tab.

32673 Orbital polarization and the insulating gap in the transition-metal oxides. Norman, M.R. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439 (USA)). *Physical Review Letters (USA)*, 64(10): 1162-1165 (5 Mar 1990). DOE Contract W-31109-ENG-38.

It is shown that an orbital-polarization correction to a spin-polarized band-structure calculation leads to an insulating gap for CoO, in sharp contrast to a standard band calculation. Orbital-polarization instabilities, though, are not found for FeO and La_2CuO_4.

32674 Thermal conductivity of condensed D-T and T_2. Collins, G.W. (Department of Physics, Ohio State University, Columbus, Ohio 43210 (US)); Souers, P.C.; Fearon, E.M.; Mapoles, E.R.; Tsugawa, R.T.; Gaines, J.R. *Physical Review, B: Condensed Matter (USA)*, 41(4): 1816-1823 (1 Feb 1990). DOE Contract W-7405-ENG-48.

The thermal conductivity of condensed T_2 and D-T has been measured by conventional techniques. Measurements for solid T_2 and D-T (D_2-DT-T_2) from the triple points to 3 K are presented, along with measurements in the liquid phases from the triple points to 25 K. The sample geometry was that of a thin disk, a single heater being used to produce a temperature difference between the faces of the disk. The steady-state thermal conductivity of the solid increases from 0.15 W/m K at 3 K to between 0.5 and 0.7 W/m K at 8 to 10 K before dropping to 0.3 W/m K at the triple points. Two T_2 samples had large thermal conductivities (≈1.2 W/m K) at 9 K, probably caused by accidentally good sample packing. The liquid thermal conductivity increases from 0.3 W/m K at the triple points to between 2 and 6 W/m K at 25 K, with convection of the liquid being probable. The effect of shrinkage upon freezing is considered, and an unexplained time-dependent behavior, seen in both T_2 and D-T, is described. The considerable importance of the solid thermal conductivity to nuclear spin polarization of D-T is discussed in detail. The need for a triton spin-lattice-relaxation time greater than 100 s

is made evident by the need to remove the heat due to tritium decay and that from microwave pumping of the electron spins.

32675 Synthesis, structure, and properties of $Sr_2CuO_2Cl_2$. Miller, L.L. (Ames Laboratory and Department of Physics, Iowa State University, Ames, Iowa 50011 (US)); Wang, X.L.; Wang, S.X.; Stassis, C.; Johnston, D.C.; Faber, J. Jr.; Loong, C. *Physical Review, B: Condensed Matter (USA),* 41(4): 1921-1925 (1 Feb 1990). DOE Contract W-31109-ENG-38.

Syntheses of single-crystal specimens and single-phase polycrystalline samples of $Sr_2CuO_2Cl_2$ are reported. Differential-thermal-analysis measurements indicate that this compound melts incongruently at 990 °C in air and at 970 °C in helium. Rietveld refinement of powder neutron diffraction data confirms the body-centered-tetragonal ($I4/mmm$) K_2NiF_4-type structure found earlier using x-ray techniques by Grande and Mueller-Buschbaum. The CuO_2 planes are the same as in (tetragonal) La_2CuO_4, but the out-of-CuO_2-plane oxygens in the latter are replaced by Cl. The temperature dependences of the lattice parameters and thermal factors are reported; the tetragonal structure is retained from 300 K down to at least 25 K. Electrical-resistivity measurements exhibit essentially insulating behavior near room temperature, with $\rho_{ab} \cong 3000\ \Omega$ cm and $\rho_c \cong 6.5 \times 10^5\ \Omega$ cm.

32676 Antiferromagnetism in $Sr_2CuO_2Cl_2$. Vaknin, D. (Exxon Research and Engineering Company, Annandale, New Jersey 08801 (US)); Sinha, S.K.; Stassis, C.; Miller, L.L.; Johnston, D.C. *Physical Review, B: Condensed Matter (USA),* 41(4): 1926-1933 (1 Feb 1990). DOE Contract AC02-76CH00016.

Magnetic-susceptibility $\chi(T)$ and neutron-diffraction studies on single-crystal specimens of $Sr_2CuO_2Cl_2$ are reported. A three-dimensional antiferromagnetic structure similar to that in La_2CuO_4 is identified below the Neel temperature $T_N = 251 \pm 5$ K by neutron diffraction, with an ordered moment $\mu(10\ \text{K}) = 0.34 \pm 0.04\ \mu_B$/Cu aligned along the [110] crystal direction. This moment is comparable to those for La_2CuO_4 samples with similar T_N. No structural transition from the tetragonal $I4/mmm$ space group is observed between 10 and 300 K. The $\chi(T)$ near T_N is consistent with the tetragonal structure, showing no evidence for the peak at T_N seen in orthorhombic La_2CuO_4, arising from the Dzyaloshinsky-Moriya interaction, which is absent without the orthorhombic distortion. Above T_N the exchange coupling constant J between adjacent Cu ions is evaluated from $\chi(T)$ and found to be essentially identical to that in La_2CuO_4. The anisotropic Cu spin and Van Vleck susceptibilities are also estimated from the analysis.

32677 Complex magnetic properties of the rare-earth copper oxides, R_2CuO_4, observed via measurements of the dc and ac magnetization, EPR, microwave magnetoabsorption, and specific heat. Oseroff, S.B. (San Diego State University, San Diego, California 92182 (US)); Rao, D.; Wright, F.; Vier, D.C.; Schultz, S.; Thompson, J.D.; Fisk, Z.; Cheong, S.; Hundley, M.F.; Tovar, M. *Physical Review, B: Condensed Matter (USA),* 41(4): 1934-1948 (1 Feb 1990).

We report the results of an extensive investigation of the magnetic properties of a large series of undoped R_2CuO_4 single crystals with R==Pr, Nd, Sm, Eu, and Gd (which are the host compounds for the newly discovered series of electron cuprate superconductors) and mixture versions of the form $A_{2-x}B_xCuO_4$, with A==Pr, Nd, Sm, Eu, or Gd, and B==Gd, Tb, or Dy. We have measured dc and ac magnetization, microwave magnetoabsorption, EPR, and specific heat. These measurements reveal two characteristic transition temperatures associated with a novel complex magnetic behavior, including weak ferromagnetism, two sharp peaks in the low-field dc magnetization, an unusual anisotropy in the EPR resonance field for R=Gd, and two additional anisotropic microwave absorption modes. The higher characteristic transition temeperature at ~270 K is associated with antiferromagnetic ordering of the Cu moments which are strongly coupled within the CuO_2 layers. The lower, at $\leq$20 K, cannot be attributed to antiferromagnetic ordering of the $\bar{R}$ moments and is tentatively attributed to a spontaneous canted spin reorientation. An understanding of this magnetic behavior is important in order to ascertain its relationship to possible mechanisms of high-temperature superconductivity.

32678 Evidence for a charge-density wave or spin-density wave in the Cu-O chains in $YBa_2Cu_3O_{7-x}$. Huang, W.F. (Department of Physics, University of Louisville, Louisville, Kentucky 40292 (USA)); Xu, Z.J.; Liu, S.H.; Wu, M.K. *Physical Review, B: Condensed Matter (USA),* 41(4): 2052-2056 (1 Feb 1990). DOE Contract AC05-84OR21400.

The Doppler-broadened positron annihilation spectra of polycrystalline samples of $YBa_2Cu_3O_{7-x}$ have been measured and analyzed. By studying the difference between the normal-state (room-temperature) and superconducting-state (liquid-nitrogen temperature) spectra, we have deduced that the valence electrons undergo a significant redistribution in momentum states when the material becomes superconducting. We present evidence to demonstrate that this redistribution is consistent with the formation of a static charge-density wave or spin-density wave in the Cu-O chains either concurrent or very closely associated with the superconducting transition.

32679 Elastic constants and specific-heat measurements on single crystals of La_2CuO_4. Migliori, A. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)); Visscher, W.M.; Brown, S.E.; Fisk, Z.; Cheong, S.; Alten, B.; Ahrens, E.T.; Kubat-Martin, K.A.; Huang, Y.; Kirk, D.R. *Physical Review, B: Condensed Matter (USA),* 41(4): 2098-2102 (1 Feb 1990).

We measured all nine elastic constants of a nonsuperconducting single crystal of La_2CuO_4 at 310, 297, and 44 K using a small-sample resonant ultrasound technique. Weak features in resonant frequencies dependent on compressional moduli were observed near 29 K, and a broad minimum occurred at 38 K, near the superconducting transition temperature of optimally doped La_2CuO_4. The features are also reflected in the specific heat.

32680 Magnetic ordering of Nd in $(Nd,Ce)_2CuO_4$. Lynn, J.W. (Center for Superconductivity Research, Department of Physics, University of Maryland, College Park, Maryland 20742 (US)); Sumarlin, I.W.; Skanthakumar, S.; Li, W.; Shelton, R.N.; Peng, J.L.; Fisk, Z. *Physical Review, B: Condensed Matter (USA),* 41(4): 2569-2572 (1 Feb 1990).

Neutron-diffraction techniques have been used to study the magnetic ordering of the Nd ions in semiconducting Nd_2CuO_4 and superconducting $Nd_{1.85}Ce_{0.15}CuO_4$. For the Ce-doped system a sharp transition to long-range antiferromagnetic order occurs at $T_N \approx 1.2$ K, with a simple magnetic unit cell which is double the chemical unit cell along the a and b directions. The same magnetic structure is observed in the parent system Nd_2CuO_4, in which the Cu spins are also ordered magnetically, but strong coupling between the Nd and Cu sublattices is indicated.

32681 Hole excitation spectra in cuprate superconductors: A comparative study of single- and multiple-band strong-coupling theories. Chen, C. (Center for Simulational Physics, University of Georgia, Athens, Georgia 30602 (US)); Schuettler, H.; Fedro, A.J. *Physical Review, B: Condensed Matter (USA),* 41(4): 2581-2584 (1 Feb 1990). DOE Contract W-31109-ENG-38.

We compare ground-state properties as well as spin and single-particle excitation spectra of a single dopant-induced hole carrier in strong-coupling-limit single-orbital and three-orbital Hubbard model lattices with up to 16 square lattice sites. Our results indicate that there is a close correspondence in their ground-state and low-lying excited-state properties, consistent with the recent proposal by Zhang and Rice (ZR). For the three-orbital model, we also find direct spectroscopic evidence for the singlet-triplet excitation gap associated with the dopant-induced ZR Cu-O spin-hole singlet state.

32682 Hydrogen vibrational modes and anisotropic potential in α-ScH_x. Udovic, T.J. (Materials Science Laboratory,National Institute of Standards and Technology, Gaithersburg, Maryland 20899 (USA)); Rush, J.J.; Anderson, I.S.; Barnes, R.G. *Physical Review, B: Condensed Matter (USA),* 41(6): 3460-3465 (15 Feb 1990).

The hydrogen vibrational spectra of single-crystal α-ScH_x (x=0.05, 0.16, and 0.25) have been measured using incoherent-inelastic-neutron-scattering methods. Alignment of the momentum-transfer vector **Q** either perpendicular or parallel to the c axis permitted the selective enhancement in scattering sensitivity of the different normal modes of the tetrahedrally bound hydrogen.

The results show that the *c*-axis vibration peak (at ca. 103 meV) is over 30% lower in energy than the doubly degenerate basal-plane modes (at ca. 148 meV) and possesses considerable anharmonicity, as reflected by the ratio (1.76) of the second- to first-excited-state energies. High-resolution neutron spectra for the *c*-axis vibrations revealed a peak at all hydrogen concentrations that is much broader (ca. 14 meV full width at half maximum intrinsic linewidth, x=0.25) than the instrumental resolution, yet devoid of any resolved fine structure indicative of a distinct local-mode splitting as was observed previously for α-YH_x. This suggests that although local ordering via hydrogen pairing across a Sc atom exists within α-ScH_x at low temperature, ordering of the hydrogen pairs themselves along the *c* axis is less extensive than in α-YH_x.

32683 Phase seperation in a high-pressure-oxygenated $La_2CuO_{4+\delta}$ crystal: Evidence from anisotropic electronic transport and magnetic susceptibility. Hundley, M.F. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (USA)); Thompson, J.D.; Cheong, S.; Fisk, Z.; Schirber, J.E. *Physical Review, B: Condensed Matter (USA)*, 41(7): 4062-4065 (1 Mar 1990). DOE Contract AC04-76DP00789.

We report magnetic susceptibility, resistivity, and thermoelectric power measurements performed on a high-pressure-oxygenated $La_2CuO_{4+\delta}$ single crystal. Distinct anomalies are present in all three quantities between 200 and 280 K that are attributed to a phase separation involving oxygen diffusion. Hysteresis present in the data near the phase-separation temperature indicates that the process is weakly first order. We suggest that this transition may be driven, in part, by interactions between excess oxygen ions and copper spin magnetism.

32684 $BaBiO_3$ and the effect of potassium substitution using photoemission. Jeon, Y. (Department of Physics, Rutgers University, Piscataway, New Jersey 08855 (USA)); Liang, G.; Chen, J.; Croft, M.; Ruckman, M.W.; Di Marzio, D.; Hegde, M.S. *Physical Review, B: Condensed Matter (USA)*, 41(7): 4066-4071 (1 Mar 1990). DOE Contract AC02-76CH00016.

The electronic structure and surface stability of $BaBiO_3$ and $Ba_{0.6}K_{0.4}BiO_3$ are studied using photoemission. For $BaBiO_3$ and $Ba_{0.6}K_{0.4}BiO_3$, bonding and nonbonding valence-band features show good agreement with theoretical calculations reported by Takegahara and Kasuya, and Mattheiss and Hamman, and Hamada *et al.* However, the magnitude of Bi 6*s* and O 2*p* antibonding states near the Fermi level are less than expected, and the Ba 5*p* core levels are at a higher energy than reported by Wertheim *et al.* The Bi 5*d* core levels show a single component for $Ba_{0.6}K_{0.4}BiO_3$ but show two components for $BaBiO_3$, and the large shift (~1.6 eV) of the second component to lower binding energy suggests the possible reduction of surface Bi to the metallic state. Examination of extended x-ray-absorption fine-structure data by Heald *et al.*, obtained from these materials, show that a weaker Bi-O bond exists in $BaBiO_3$ than in $Ba_{0.6}K_{0.4}BiO_3$, and this may explain why such bonds are easily broken in $BaBiO_3$.

32685 Magnetic order of the Cu planes and chains in $RBa_2Cu_3O_{6+x}$. Li, W. (Center for Superconductivity Research, Department of Physics, University of Maryland, College Park, Maryland 20742 (USA)— National Institute of Standards and Technology, Gaithersburg, Maryland 20899 (USA)); Lynn, J.W.; Fisk, Z. *Physical Review, B: Condensed Matter (USA)*, 41(7): 4098-4111 (1 Mar 1990).

Polarized and unpolarized neutron-diffraction measurements have been taken to determine the magnetic structure of the Cu spins in the $RBa_2Cu_3O_{6+x}$ system as a function of temperature. Most of the results have been obtained on two (semiconducting) oxygen-deficient single crystals of composition $NdBa_2Cu_3O_{6.1}$ and $NdBa_2Cu_3O_{6.35}$. On cooling from the paramagnetic state, the Cu-O "plane" layers first order at a Neel temperature T_{N1} in a simple antiferromagnetic arrangement of spins, with T_{N1}=430 K for x=0.1 and T_{N1}=230 K for x=0.35, and with a saturated moment of ~0.65 μ_B. At a lower temperature T_{N2} the Cu "chain" layer also orders, with T_{N2}=80 and 10 K for x=0.1 and 0.35, respectively. Hence both transition temperatures decrease with increasing oxygen concentration in this range of x, and the qualitative behavior for these two samples is found to be identical.

32686 Calcium-substituted Y-Ba-Cu-O superconductors with enhanced T_c synthesized at elevated oxygen pressures. Morris, D.E. (2-300 Lawrence Berkeley Laboratory, Berkeley, California 94720 (USA)); Narwankar, P.; Sinha, A.P.B.; Takano, K.; Fayn, B.; Shum, V.T. *Physical Review, B: Condensed Matter (USA)*, 41(7): 4118-4122 (1 Mar 1990).

Calcium substitution in the Y-Ba-Cu-O system at elevated $P(O_2)$ results in superconducting compounds with novel and enhanced properties: tetragonal $Ca_xY_{(1-x)}Ba_2Cu_3O_y$ with T_c=86 K for x=0.2 prepared at $P(O_2)$=16 bars, and $Ca_xY_{(1-x)}Ba_2Cu_4O_y$ (1:2:4) with T_c=89 K for x=0.1 prepared at 50–200 bars. Calcium substitution shifts the phase-stability boundary between 1:2:3, 2:4:7, and 1:2:4 phases to higher $P(O_2)$, and stabilizes a tetragonal 1:2:3 structure at moderately elevated $P(O_2)$ *without* substantial decrease in T_c. The T_c of 1:2:4 increases with Ca substitution up to x=0.1, and then decreases gradually for larger x, possibly because of excessive hole concentration.

32687 Structural phase diagram of the $Ba_{1-x}K_xBiO_3$ system. Pei, S. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439 (USA)); Jorgensen, J.D.; Dabrowski, B.; Hinks, D.G.; Richards, D.R.; Mitchell, A.W.; Newsam, J.M.; Sinha, S.K.; Vaknin, D.; Jacobson, A.J. *Physical Review, B: Condensed Matter (USA)*, 41(7): 4126-4141 (1 Mar 1990). DOE Contract W-31109-ENG-38.

The structures of five phases in the $Ba_{1-x}K_xBiO_3$ system for $0 \leq x \leq 0.5$ and temperatures below 473 K have been determined by neutron powder diffraction. Bulk superconductivity occurs only in a cubic perovskite phase which exists for $x \geq 0.37$ (at 10 K). At room temperature, as the potassium concentration is decreased, the cubic structure distorts first by BiO_6 octahedral tilting and then by symmetric oxygen breathing-mode distortions. Semiconducting behavior for the monoclinic phase at $0 \leq x \leq 0.1$ can readily be explained on the basis of a commensurate charge-density wave. The semiconducting orthorhombic phase, which extends from the monoclinic phase to the cubic superconducting phase, contains only octahedral tilting distortions that would not be expected to destroy metallic behavior. Thus, this commensurate structure provides no explanation for the metal-insulator transition. An incommensurate modulation extending across the semiconducting region of the phase diagram has been observed by electron diffraction, but is not observed by neutron diffraction. It is not clear whether this incommensurate modulation is responsible for the nonmetallic behavior.

32688 Structural and superconducting properties of oxygen-deficient $NdBa_2Cu_3O_{7-\delta}$. Shaked, H. (Nuclear Research Center-Negev, Post Office Box 9001, Beer Sheva, Israel (IL)— Ben Gurion University of the Negev, Post Office Box 653, Beer Sheva, Israel (IL)); Veal, B.W.; Faber, J. Jr.; Hitterman, R.L.; Balachandran, U.; Tomlins, G.; Shi, H.; *Physical Review, B: Condensed Matter (USA)*, 41(7): 4173-4180 (1 Mar 1990). DOE Contract W-31109-ENG-38.

Neutron diffraction was used to determine the structural properties of oxygen deficient $NdBa_2Cu_3O_{7-\delta}$ for $0.09 < \delta < 0.74$. It was found that superconductivity disappears at the orthorhombic-to-tetragonal phase transition which occurs at δ_{OT}=0.45. Structural parameters vary smoothly with δ but exhibit a change in slope at the orthorhombic-to-tetragonal transition. The structural properties exhibit the same features found in $YBa_2Cu_3O_{7-\delta}$ where δ_{OT}=0.65. It is shown that the repulsion energy of oxygen atoms in the O(1) and O(5) sites in $NdBa_2Cu_3O_{7-\delta}$ is smaller than in $YBa_2Cu_3O_{7-\delta}$. This lower repulsion energy stabilizes the orthorhombic phase at lower values of δ. It is argued that the disappearance of superconductivity at the orthorhombic-to-tetragonal transition is an inherent property of the $RBa_2Cu_3O_{7-\delta}$ (R denotes rare earth) system.

32689 O 2*p* holes: Temperature effects and surface characteristics of cuprate superconductors. Wagener, T.J. (Department of Chemical Engineering— Department of Materials Science, University of Minnesota, Minneapolis, Minnesota 55455 (USA)); Meyer, H.M. III; Hu, Y.; Jost, M.B.; Weaver, J.H.; Goretta, K.C. *Physical Review, B: Condensed Matter (USA)*, 41(7): 4201-4211 (1 Mar 1990).

The O 2*p* holes in the Cu- and Bi-based oxide superconductors La-Sr-Cu-O, Y-Ba-Cu-O, Bi-Sr-Ca-Cu-O, Tl-Ba-Ca-Cu-O, and

Ba-K-Bi-O, and in CuO have been investigated with inverse photoelectron spectroscopy. These states exhibit a unique resonance for incident electron energies near the O 2*s* shallow core in the Cu-based superconductors but it is not observed in CuO or in Ba-K-Bi-O. Variations in the resonance show that the number of O 2*p* holes (1) increases at 60 K compared to 300 K, (2) is significantly reduced in oxygen-deficient samples, (3) is altered but not quenched upon Pr substitution for Y, (4) is reduced by electron bombardment at ~1500 eV, and (5) is quenched by Cu- or Au-adatom-induced surface disruption. The Bi-Sr-Ca-Cu-O surfaces are found to be the most stable against high-energy electron bombardment and interface formation.

32690 Major normal and superconducting parameters of high-T_c oxides. Kresin, V.Z. (Materials and Chemical Sciences Division— Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720 (USA)); Wolf, S.A. *Physical Review, B: Condensed Matter (USA),* 41(7): 4278-4285 (1 Mar 1990). DOE Contract AC03-76SF00098.

The major normal and superconducting parameters of the high-T_c oxides have been evaluated. The analysis based on a Fermi-liquid approach is carried out in reciprocal space: the anisotropy of the system is reflected in the shape of the Fermi surface. The analysis is valid for any form of the Fermi curve. The small value of the Fermi energy and the Fermi velocity we obtained along with the presence of a layered structure are the key features of the cuprates. The coherence length ξ_0 is evaluated and appears to be short. The value of H_{c2} is calculated in a self-consistent way. The method of evaluation of the strength of the electron-phonon coupling is developed and leads to a strong coupling which, however, is not sufficient to give the observed value of T_c. The effects of anisotropy and multigap structure are discussed.

32691 Infrared synchrotron-radiation transmission measurements on $YBa_2Cu_3O_{7-\delta}$ in the gap and supercurrent regions. Williams, G.P. (Brookhaven National Laboratory, Upton, New York 11973 (USA)); Budhani, R.C.; Hirschmugl, C.J.; Carr, G.L.; Perkowitz, S.; Lou, B.; Yang, T.R. *Physical Review, B: Condensed Matter (USA),* 41(7): 4752-4755 (1 Mar 1990). DOE Contract AC02-76CH00016.

We report infrared synchrotron-radiation transmission measurements on ~1-μm-thick films of high-T_c $YBa_2Cu_3O_{7-\delta}$ from 40 to 290 cm^{-1} (5 to 36 meV). The films were deposited onto MgO substrates and showed resistive superconducting transitions with an onset at 83 K. Spectra below T_c show superconducting behavior, including the characteristic $1/\omega$ supercurrent dependence for frequencies below 100 cm^{-1}. The entire spectrum can be fit when a Mattis-Bardeen-type conductivity is included identifying increasing absorption beginning at a photon energy of 23 meV. However, a substantial residual absorption persists to the lowest measured frequencies. In addition, the appearance of phonons, some attributable to *c*-axis vibrations, suggests we are sampling a mixture of both *a-b*-plane and *c*-axis properties.

32692 Effects of zinc substitution on the electron superconductor $Nd_{1.85}Ce_{0.15}CuO_{4-\delta}$. Barlingay, C. (Department of Materials Science— Department of Engineering, University of Arizona, Tucson, Arizona 85721 (USA)); Garcia-Vazquez, V.; Falco, C.M.; Mazumdar, S. *Physical Review, B: Condensed Matter (USA),* 41(7): 4797-4800 (1 Mar 1990). DOE Contract FG02-87ER45297.

We report the effects of Zn substitution for Cu on the superconducting properties of the electron superconductor $Nd_{1.85}Ce_{0.15}CuO_{4-\delta}$. Detailed comparisons are made to earlier work on Zn substitution effects on the single-CuO_2-layer hole superconductor $La_{1.85}Sr_{0.15}CuO_{4-\delta}$. Theoretical implications are discussed briefly.

32693 Magnetic ordering in $(Y_{1-x}Pr_x)Ba_2Cu_3O_7$ as observed by muon-spin relaxation. Cooke, D.W. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (USA)); Kwok, R.S.; Lichti, R.L.; Adams, T.R.; Boekema, C.; Dawson, W.K.; Kebede, A.; Schwegler, J.; Crow, J.E.; Mihalisin, T. *Physical Review, B: Condensed Matter (USA),* 41(7): 4801-4804 (1 Mar 1990).

Zero-field positive muon-spin-relaxation (μ^+SR) measurements on $(Y_{1-x}Pr_x)Ba_2Cu_3O_7$ (x=1.0, 0.8, 0.6, 0.58, and 0.54) show clear evidence for antiferromagnetic ordering of the Cu moments within the Cu-O planes. Neel temperatures are approximately 285, 220, 35, 30, and 20 K for x=1.0, 0.8, 0.6, 0.58, and 0.54, respectively. For x=0.50 we observe a fast-relaxing component and a long-time tail of the muon polarization, reminiscent of spin-glass behavior. Superconductivity and spin-glass-like magnetism appear to coexist for x near 0.50. For x=1.0 the fully developed local magnetic field is ~16 mT, but decreases to ~12 mT at T=17 K, presumably due to the onset of additional ordering. The Neel temperature for oxygen-reduced $PRBa_2Cu_3O_6$ is approximately 325 K.

32694 Polarized resonance photoemission for Nd_2CuO_4. Gunnarsson, O. (Max-Planck-Institut fuer Festkoerperforschung, Postfach 800665, D-7000 Stuttgart 80, West Germany (DE)); Allen, J.W.; Jepsen, O.; Fujiwara, T.; Andersen, O.K. *Physical Review, B: Condensed Matter (USA),* 41(7): 4811-4814 (1 Mar 1990). DOE Contract FG03-86ER45230.

We present calculations of resonance photoemission spectra for Nd_2CuO_4. The calculations use a model Hamiltonian for which all parameters for the valence electrons are obtained from *ab initio* calculations or atomic data. Most features of the calculated sp agree well with experiment where comparison is possible. A substantial dependence on the polarization of the light is predicted for the occurrence of resonance behavior, and for the off-resonance intensity of the local singlet and one of the satellites.

32695 Unifying trends found for the V_NO_{2N-1} series by the application of hydrostatic pressure. Canfield, P.C. (Department of Physics, University of California at Los Angeles, 405 Hilgard Avenue, Los Angeles, California 90024 (USA)); Thompson, J.D. *Physical Review, B: Condensed Matter (USA),* 41(7): 4850-4853 (1 Mar 1990).

The application of hydrostatic pressure to V_7O_{13}, V_8O_{15} and $(V_{0.98}Cr_{0.02})_8O_{15}$ leads to the formation of pressure-temperature phase diagrams for each of these materials. Analysis of these diagrams allows unifying trends, not apparent at atmospheric pressure, to emerge. Examination of these trends and the nature of the low-temperature antiferromagnetic ground state will be presented.

32696 Electronic structure and optical properties of LiB_3O_5. Xu, Y. (Department of Physics, University of Missouri-Kansas City, Kansas City, Missouri 64110 (USA)); Ching, W.Y. *Physical Review, B: Condensed Matter (USA),* 41(8): 5471-5474 (15 Mar 1990). DOE Contract FG02-84ER45170.

The band structure and the interband optical conductivity of a LiB_3O_5 crystal with excellent nonlinear optical properties are studied by means of a first-principles method. The electronic structure is characterized by highly localized bands with a direct gap of 7.37 eV at Γ and a very low static dielectric constant of 2.7. The optical absorption curve shows several prominent structures but with very small directional anisotropy. The calculated frequency-dependent refractive index is in good agreement with experimental data.

32697 Energy beam treatment for improved adhesion of coatings to surfaces. Singer, I.L. To Department of the Navy, Washington, DC. USA Patent Application 7-429,959. 31 Oct 1989. 38p. Available from NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

The present invention relates to engineering materials in general and more specifically to the coating of bulk engineering material with corrosion, oxidation or wear resistant inorganic materials. Coatings are needed for protecting engineering components against mechanical, tribological and corrosive/oxidative degradation. In particular, engineering ceramics, by virtue of their light weight, high strength and thermal stability, have great potential for many high temperature applications. However, several of the best and toughest candidate ceramics, e.g. Silicon Carbide, Silicon Nitride, and Tungsten Carbide, require oxide coatings to resist corrosion and oxidation at high temperatures (900 C and up). The coating of a substrate with a coating different from and non-reactive with the substrate is improved by energetic surface alloying of the substrate prior to coating. The ion implantation alters the stoichiometry of the substrate, creating a substrate surface which is reactive with the coating. For example, the bonding of TiN to Si_3N_4 is enhanced by implanting the substrate surface with Ti. Patent applications.

3606 Other Materials

Refer also to citation(s) 32071, 32129, 32190, 32213, 32245, 32250, 32487, 32529, 32565, 32609, 32612, 32628, 32635, 32637, 32642, 32671, 32697, 32791, 32815, 32824, 32882, 32985, 32987, 33008, 33012, 33033, 33185

32698 (CONF-900302–1) **Atomic scale imaging of the structure and chemistry of semiconductor interfaces.** Pennycook, S.J.; Jesson, D.E.; Chisholm, M.F. Oak Ridge National Lab., TN (USA). May 1990. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From SPIE's symposium on advances in semiconductors and superconductors: physics toward device applications; San Diego, CA (USA); 17-21 Mar 1990. Order Number DE90011321. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A new technique for high-resolution electron microscopy is described together with a number of applications involving semiconductor interfaces. Optically this technique represents the realization of incoherent imaging at atomic resolution, with the advantages over conventional coherent imaging methods of improved resolution and an unambiguous, simply interpretable image. In addition, the image shows strong compositional sensitivity, thus providing a direct map of a material's structure and chemistry on the atomic scale. 24 refs., 14 figs.

32699 (CONF-900466–35) **Electron microscopy of interfaces in silicon carbide whisker-reinforced alumina composites.** Alexander, K.B.; Angelini, P.; Becher, P.F. Oak Ridge National Lab., TN (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90010439. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Knowledge about the nature of interfaces between SiC whiskers and alumina matrices is critical to understanding the mechanical behavior of these types of composites. The fracture toughness, in particular, is strongly influenced by the bond characteristics of this interface. Previous results have shown that oxidizing the whiskers in air prior to composite fabrication by vacuum hot-pressing results in composites which have lower toughness compared to those made with whiskers in the as-received condition. This investigation focusses on the effects of oxidizing and reducing surface treatments on the whiskers themselves and on the whisker-matrix interface. High resolution electron microscopy (HREM) was used to characterize the morphology and the amount of amorphous phase at the whisker-matrix interface, as well as the crystallography and topography of the interface. The present results indicate that the characteristics of the whisker/matrix interface may not be directly related to the initial whisker surface chemistry. Surprisingly, the thickest thermally-grown oxide layer resulted in the thinnest amorphous film at the SiC/Al_2O_3 interface. 9 refs., 9 figs.

32700 (CONF-900737–1) **Improvements in macroreticular particles for ion-exchange and gel-permeation chromatography.** Watson, J.S. Oak Ridge National Lab., TN (USA). [1990]. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Ion-Ex '90; Cartrefle (UK); 9-11 Jul 1990. Order Number DE90003717. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The effectiveness of chromatographic processes is often limited by the resistance to mass transfer into the exchanger particles. The likelihood of the exchange process being limited by particle diffusion resistance is especially high when one or both of the exchanging ions has a high molecular weight, and thus large molecular size and low mobility within the particles. Separation of ionic species from bioreactors is likely to involve such high molecular weight species and slow diffusion rates. Macroreticular particles are more effective in these applications because the larger specie can diffuse more freely into the inner regions of the particles through large pores. The effects of small viscous flow rates through the larger pores of the macroreticular particle structure are examined in this paper to show how such flow can increase exchange rates. The importance of such flow is evaluated in terms of an effective diffusivity within the particle. The performance of an ion-exchange material can be affected strongly by the dimensions of its internal structure. The approach used to describe and evaluate the performance of ion-exchange materials with high-molecular-weight ions can be applied to macroreticular particles for separation of biological species and polymers by gel permeation. 7 refs., 2 figs.

32701 (CONF-900742–2) **Thermodynamic calculations for mixtures of environmentally safe refrigerants using the Lee-Kesler-Ploecker equation of state.** Fischer, S.K.; Sand, J.R. Oak Ridge National Lab., TN (USA). [1990]. 11p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From International compressor engineering conference, USNC/IIR-Purdue refrigeration conference and ASHRAE-Purdue CFC conference; West Lafayette, IN (USA); 17-20 Jul 1990. Order Number DE90010493. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The imminent phaseout of R-11, R-12, and R-115 because of their high ozone depletion potentials has prompted many independent investigations of alternative or substitute refrigerants, either as pure compounds or as mixtures of two or more environmentally acceptable fluids. There are several motivations for investigating mixtures. There are very few pure compounds which can be used for refrigerants that are non-toxic, non-flammable, and also have very low ozone depleting potentials (ODP) and greenhouse warming potentials (GWP). Mixtures composed of three or more components offer a distinct advantage in that careful selection of the components could permit a flammable refrigerant to be used in a blend that remains non-flammable under all conceivable conditions. Also, component concentrations in ternary or higher order mixtures can be adjusted to linearize the temperature-enthalpy profile of a mixture making it more suitable for applications where secondary fluids are heated or cooled through large temperature glides (i.e., refrigeration and air conditioning). The computer model LKPSIM was constructed from subroutines written by Ulf Ploecker and incorporated into a Lorenz cycle refrigerator/freezer simulation model for binary refrigerant mixtures developed at the University of Hannover. Modifications were made to the Hannover routines to compute thermodynamic properties for mixtures of three or more components, the list of available refrigerants was expanded from 11 to 17 possible choices, and a new correlation was developed for computing the interaction coefficients for mixtures of halocarbon refrigerants. Tables of refrigerant molecular weights, critical temperatures and pressures, normal boiling points, acentric factors, and coefficients for fits to the ideal gas heat capacity for each refrigerant are built into a menu-driven data input routine for ease of use. 11 refs., 6 figs., 2 tabs.

32702 (DOE/ER/13591–4) **Polymer-based separations: Synthesis and application of polymers for ionic and molecular recognition: Annual performance report, August 1, 1989–July 31, 1990.** Alexandratos, S.D. Tennessee Univ., Knoxville, TN (USA). Dept. of Chemistry. Apr 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-86ER13591. Order Number DE90010791. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The current period has focused upon (1) the development of metal ion separations with the dual mechanism bifunctional polymers which we introduced, and (2) the initiation of studies into developing polymer-supported reagents for molecular separations. Our research has focused on gaining an understanding of the mechanisms of action displayed by polymers under different solution conditions. This would then allow us to propose efficient utilization methodologies for the dual mechanism bifunctional polymers and to design additional DMBPs with different specificities. This report briefly discusses progress in the two areas of work previously mentioned.

32703 (JAERI-M–90-009) **Effect of high temperature neutron irradiation on physical properties of OGL-1 graphite block.** Matsuo, Hideto (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Minato, Kazuo; Imai, Hisashi. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 28p. (In Japanese). Order Number DE90791149. Available from NTIS (US Sales Only), PC A03/MF A01.

Irradiation experiments on the small specimens of the IG-110 graphite for the HTTR have been carried out in the JMTR, JRR-2, and HFR, and the effect of high temperature neutron irradiation on

physical properties of the graphite material has become clear. However, a full-scale graphite block has distributions of temperature and neutron fluence in actual service conditions. These may lead to the generation of stress in the blocks and then the property changes in addition to irradiation effects. In order to clarify the property changes of a large graphite block, thermal expansivity, electrical resistivity and Young's modulus were measured for the specimens taken from the four OGL-1 graphite blocks, the fourth to seventh graphite blocks, and compared with the results previously obtained for small specimens. The thermal expansivity showed a little different irradiation behavior and did not necessarily coincide with those of small specimens for each graphite block, however the overall changes of the four graphite blocks were not so clear within the scattering of data for the measured values. Electrical resistivity and Young's modulus showed similar changes to those of small specimens, respectively. (author).

32704 (K/TR–90/1) **Binder with base of aqueous solution of alkaline silicates, how to obtain it and its applications.** Oak Ridge Gaseous Diffusion Plant, TN (USA); Van Baerle and Cie AG (Switzerland). 1990. 13p. Translation of French Patent 76 34630, June 17, 1977. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OT21400. Order Number DE90011044. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The invention involves binders consisting of a solution of a mixture of potassium silicate and/or sodium silicate with lithium silicate that can be used, preferably for the production of welding electrodes, as well as a process for producing these binders and an application of these binders. The purpose of the invention consists of improving water resistance by a partial replacement by lithium of the sodium and/or potassium in the usual alkaline silicates because it is known that lithium silicate is only slightly soluble or even practically non-soluble in water. In this respect, it could not have been predicted that even the smallest proportions of lithium silicate would have such a strong influence on solubility or rehydration.

32705 (N–90-15146) **A new technique for simulating composite material. Task 2: Analytical solutions with generalized impedance boundary conditions (GIBCs). Report, September 1989-February 1990.** Ricoy, M.A.; Volakis, J.L. Michigan Univ., Ann Arbor, MI (USA). Dec 1989. 39p. (NASA-CR–186249;NAS–1.26:186249;UM–025921-8-T). Available from NTIS, PC A03/MF A01.

The diffraction problem associated with a multilayer material slab recessed in a perfectly conducting ground plane is formulated and solved via the Generalized Scattering Matrix Formulation (GSMF) in conjunction with the dual integral equation approach. The multilayer slab is replaced by a surface obeying a generalized impedance boundary condition (GIBC) to facilitate the computation of the pertinent Wiener Hopf split functions and their zeros. Both E(sub z) and H(sub z) polarizations are considered and a number of scattering patterns are presented, some of which are compared to exact results available for a homogeneous recessed slab.

32706 (NAGRA-NTB–89-14) **Microbial degradation of bitumen.** Wolf, M. (Zurich Univ., Inst. fuer Pflanzenbiologie (Switzerland)). Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Apr 1989. 90p. (In German). Available from Nagra, CH-5401 Baden, Switzerland.

Also published as a thesis (Ph.D.) of the Zurich Univ.

Bitumen is used as a matrix to immobilize low and intermediate level radioactive wastes. Since the presence of microorganisms in nuclear waste repositories cannot be ruled out, it is important to quantify the microbial degradation of bitumen. Investigations were carried out both under aerobic and anaerobic conditions using a variety of cultures. It was observed that bitumen degrading microorganisms are ubiquitous and form biofilms on bitumen surfaces. In the long term bitumen degradation rates were found to be essentially independent of the culture initially inoculated. Under aerobic conditions this rate lies between 20 and 50 g of bitumen per m^2 and year, leading to the production of 14 to 40 litres $m^{-2}a^{-1}$ of CO_2 at STP. Under anaerobic conditions the degradation rate is only about 1 percent of that under aerobic conditions. A linear extrapolation for anaerobic conditions and for a surface to volume ratio typical for nuclear waste (200 litre drums) leads to 0.3 to 0.8 percent loss of bitumen matrix within 1000 years. (author) 25 figs., 10 tabs., 69 refs.

32707 (PB–90-863853/XAB) **Metal matrix composites. July 1971-February 1990 (A Bibliography from the US Patent data base). Report for July 1971-February 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 53p. Available from NTISPC N01/MF N01.

Supersedes PB–89-863955.

This bibliography contains citations of selected patents concerning fabrication methods, applications, and manufacturing equipment for metal-matrix composites. Various metal matrix composites are examined, including aluminium, nickel, copper, titanium, boron-containing, and fiber reinforced composite materials. Techniques for welding, rolling, coating, and heat treating of metal-matrix materials and components are discussed. Manufacturing methods in fabricating metal matrix components for gas turbines, internal combustion engines, nuclear reactors, x-ray detectors, aerospace vehicles, and semiconductor/superconductor devices are presented. (This updated bibliography contains 108 citations, 12 of which are new entries to the previous edition.)

32708 (PB–90-863887/XAB) **Plastics and elastomers: Ozone degradation. January 1973-December 1989 (A Bibliography from the Rubber and Plastics Research Association data base). Report for January 1973-December 1989.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 110p. Available from NTISPC N01/MF N01.

Supersedes PB–89-856728.

This bibliography contains citations concerning the effects of ozone exposure on various plastics and elastomers. Polyamides, polypropylenes, polyvinyl chlorides, polystyrenes, polyethylenes, and natural and synthetic rubbers are among the plastics and elastomers tested following various concentrations of ozone exposure. Antioxidants, antiozonants, and stabilizers are also mentioned. (This updated bibliography contains 238 citations, 19 of which are new entries to the previous edition.)

32709 (SAND–89-2389C) **Liquid crystal coatings for surface shear stress visualization in hypersonic flows.** Reda, D.C.; Aeschliman, D.P. Sandia National Labs., Albuquerque, NM (USA). [1990]. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9006153–1: 21. AIAA fluid dynamics, plasmadynamics and laser conference in conjuction with the AIAA 25th thermophysics and heat transfer conference and the 16th aerodynamic ground testing conference, Seattle, WA (USA), 18-20 Jun 1990). Order Number DE90010846. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Experiments were conducted to test the surface-shear-stress visualization capabilities of shear-stress-sensitive/temperature- insensitive liquid crystal compounds in hypersonic flow. Liquid crystal coatings were applied to the surface of a conical model, which was then exposed to a high-unit-Reynolds-number (2.3×10^7/m) Mach 5 flow. The coating was illuminated by white light, and its response to the various flow situations was monitored and recorded with standard video and high-speed movie cameras. Boundary layer transition to turbulence was clearly demarcated by the technique. The dynamic location of the transition front as a function of model angle of attack (for sharp and blunt cones, with and without boundary-layer trips) was recorded, and observations were found to be consistent with established (published) trends for hypersonic flows over conical bodies. Normal shock passage over the model during tunnel shutdown was recorded (at 400 frames/second), and the liquid crystal coating was observed to respond to this event in a time interval less than or equal to the time between sequential movie frame exposures ($\leq$ 0.0025 seconds). The liquid crystal technique has thus been demonstrated as a viable diagnostic tool for use in transient/compressible flows. 18 refs., 3 figs.

32710 (SAND–89-3001C) **Trapping of deuterium at damage in graphite.** Wampler, W.R. (Sandia National Labs., Albuquerque, NM (USA)); Doyle, B.L.; Causey, R.A.; Wilson, K. Sandia National Labs., Albuquerque, NM (USA). [1990]. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. (CONF-900505–1: 9. plasma interaction conference, Bournemouth (UK),

20-25 May 1990). Order Number DE90011234. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Enhanced retention of deuterium (D) and tritium (T) in graphite due to neutron damage could result in large T inventories in future DT fueled fusion devices such as CIT and ITER. This paper describes experiments done to characterize the effect of lattice damage on retention of D in graphite. Lattice damage was produced in several types of graphite by irradiation with 6 MeV C+ ions or with neutrons. The damaged graphite was then heated to 1200°C and exposed to D_2 gas. The concentration of D retained in the graphite was measured by nuclear reaction analysis and compared to the level of damage. In POCO, N3M and H451 graphites, D retention increased with damage at low damage levels but saturated above 0.04 dpa at a D concentration of about 650 atomic ppM. D retention in damaged highly oriented pyrolytic graphite was an order of magnitude smaller than in the other graphites indicating that crystalline microstructure is an important factor. These results indicate that neutron damage in CIT and ITER may cause retention of large inventories of tritium in graphite components. 5 refs., 4 figs., 1 tab.

32711 (SAND–90-0088C) **Improving the performance of $InAs_{1-x}Sb_x$/InSb infrared detectors grown by metal organic chemical vapor deposition.** Biefeld, R.M.; Kurtz, S.R. Sandia National Labs., Albuquerque, NM (USA). [1990]. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9006174–1: 5. international conference on metalorganic vapor phase epitaxy, Aachen (Germany, F.R.), 18-21 Jun 1990). Order Number DE90009743. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Diethylselenium and tetraethyltin were investigated as n-type dopants for InSb. Carrier concentrations between 6×10^{15} and 4×10^{18} cm^{-3} with 77 K mobilities ranging from 75, 000 to 10,000 cm^2/Vs were achieved for Sn doped InSb. Triethylantimony and trimethylindium were used to grow InSb over the temperature range of 410 – 470 C with a decrease in the p-type background occurring at 410 C. Diodes were prepared using tetraethyltin, trimethylindium and trimethylantimony at 470 C. The resulting current-voltage characteristics are improved over those of diodes grown previously using dimethyltellurium. SIMS measurements indicate a diffusion coefficient for Sn in InSb at 470 C that is approximately 1×10^{-15} cm^2/s. 8 refs., 4 figs.

32712 (SAND–90-1077C) **Characterization of chemically prepared PZT thin films.** Tuttle, B.A. (Sandia National Labs., Albuquerque, NM (USA)); Schwartz, R.W.; Doughty, D.H.; Voigt, J.A.; Carim, A.H. Sandia National Labs., Albuquerque, NM (USA). [1990]. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004193–1: Symposium on ferroelectric thin films, San Francisco, CA (USA), 18-20 Apr 1990). Order Number DE90010831. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We have systematically varied processing parameters to fabricate PZT 53/47 thin films. Polycrystalline PZT thin films were fabricated by spin depositing Pt coated SiO_2/Si substrates with alkoxide solutions. Our study focused on two process parameters: (1) heating rate and (2) excess Pb additions. We used rapid thermal processing techniques to vary heating rates from 3°C/min to 8400°C/min. Films were characterized with the following excess Pb additions: 0, 3, 5, and 10 mol %. For all process variations, films with greater perovskite content had better ferroelectric properties. Our best films were fabricated using the following process parameters: an excess Pb addition of 5 mol %, a heating rate of 8400°C/min and annealing conditions of 700°C for 1 min. Films fabricated using these process conditions had a remanent polarization of 0.27 C/m^2 and a coercive field of 3.4 MV/m. 12 refs., 4 figs.

32713 (SAND–90-1177C) **Chlorine reactive-ion-beam etching of InSb and $InAs_{0.15}Sb_{0.85}$/InSb strained-layer-superlattices.** Vawter, G.A.; Wendt, J.R. Sandia National Labs., Albuquerque, NM (USA). [1990]. 3p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900654–1: 32. electronic materials conference, Santa Barbara, CA (USA), 27-29 Jun 1990). Order Number DE90010848. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We have demonstrated that Cl_2 RIBE is a useful dry-etch technology for InSb and InAsSb/InSb Strained-Layer Superlattices (SLSs) in spite of the low vapor pressure of the In chlorides. Etching of these materials using both Cl_2 Reactive-Ion-Beam Etching (RIBE) and Ar IBE resulted in extremely smooth surfaces and well controlled etch rates with Cl_2 RIBE accelerating the etch rate by approximately a factor of two compared to Ar IBE over the range of beam energies studied. Sloped sidewalls resulted at all tested Cl_2 RIBE energies and are probably caused by sidewall passivation with In chlorides. The anisotropy and reduced etch-induced damage of Cl_2 RIBE is expected to become of critical importance in the fabrication of dense arrays of long-wavelength photodetectors. 2 figs.

32714 (UCRL–100808) **Multichip packaging technology with laser-patterned interconnects.** Barfknecht, A.T.; Tuckerman, D.B.; Kaschmitter, J.L.; McWilliams, B.M. Lawrence Livermore National Lab., CA (USA). 5 Apr 1989. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8905102–2: 39. electronic components conference, Houston, TX (USA), 22-24 May 1989). Order Number DE90010743. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A multichip silicon-on-silicon packaging technology has been developed which incorporates laser-patterned thin-film interconnects. This technology is particularly suited for application in high speed, high power, and high I/O systems where its unique characteristics provide many advantages over more traditional methods. The laser-patterned thin-film interconnects allow higher I/O densities and better electrical performance than wire bonds or TAB. The face-up, thin-film eutectic die attach technique used provides much lower thermal resistance between the substrate and the chips than solder bump die attach can achieve. In addition, laser-patterned interconnects demonstrate superior ruggedness and fatigue resistance under thermomechanical cycling and shock. This technology has been used to produce a 10-chip memory module, samples of which have been tested to relevant methods of MIL-STD 883C. 25 refs., 2 figs., 3 tabs.

32715 (UCRL–102758) **Applications of strained layer superlattices.** Smith, D.L. (Los Alamos National Lab., NM (USA)); Laurich, B.K.; Mailhiot, C. Lawrence Livermore National Lab., CA (USA). Apr 1990. 21p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900466–42: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90011204. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Because of different band-edge lineups, strain conditions, and growth orientations, various strained-layer superlattice (SLS) materials can exhibit qualitatively new physical behavior in their optical properties. We describe two examples of new physical behavior in SLS: strain-generated electric fields in polar growth axis superlattices and strained type 2 superlattices. In SLS, large electric fields can be generated by the piezoelectric effect. The fields are largest for SLS with a [111] growth axis; they vanish for SLS with a [100] growth axis. The strain generated electric fields strongly modify the optical properties of the superlattice. Photogenerated electron-hole pairs screen the fields leading to a large nonlinear optical response. Application of an external electric field leads to a large linear electrooptical response. The absorption edge can be either red or blue shifted. Optical studies of [100], [111], and [211] oriented GaInAs/GaAs superlattices confirm the existence of the strain-generated electric fields. Small band gap semiconductors are useful for making intrinsic long wavelength infrared detectors. Arbitrarily small band gaps can be reached in the type 2 superlattice InAs/GaSb. However, for band gaps less than 0.1 eV, the layer thicknesses are large and the overlap of electron and hole wavefunctions are small. Thus, the absorption coefficient is too small for useful infrared (IR) detection. Including In in the GaSb introduces strain in he InAs/GaInSb superlattice which shifts the band edges so that small band gaps can be reached in thin layer superlattices. Good absorption at long IR wavelengths is thus achieved. 22 refs., 9 figs.

32716 (UCRL-JC–103630) **Nanometer-scale pulsed laser modification of the basal plane of graphite observed with STM [scanning tunneling microscopy].** Schildbach, M.A. (California Univ., Davis, CA (USA). Dept. of Applied Science); Tench, R.J.;

Balooch, M.; Siekhaus, W.J. Lawrence Livermore National Lab., CA (USA). Apr 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-900466–32: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90010873. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Scanning tunneling microscopy has been used to document changes in the nanometer-scale morphology of the basal plane of highly oriented pyrolytic graphite after exposure to 7 ns, 1064 nm laser pulses in air. Surface modification was visible at fluences far below those that produce melting. Damage appears first on step edges and consists of exfoliation of graphite layers and recession of steps through removal of mono- or multilayer patches. 13 refs., 3 figs.

32717 (USGS-OFR–90-31) **Electric logging and electrical properties of rocks in Rainier Mesa area, Nevada Test Site, Nevada.** Carroll, R.D. Geological Survey, Denver, CO (USA). 1990. 90p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract AI08-86NV10583. Available from OSTI; USGS-OFR, USGS Open File Service, Box 25425-Denver Federal Center, Denver, CO 80225.

Electric logs obtained in 33 drill holes in the Rainier Mesa region were evaluated. Aside from the usual character correlations associated with densely welded tuffs, correlations over considerable distances in the ash-fall tuffs may be noted at the horizons of tunnel bed subunits 4J and 3D, and at the contact of tunnel bed subunit 3A and the Tub Spring Member of the Belted Range Tuff. The latter correlation is the most widespread in the bedded tuffs in the area. Although diagnostic in several holes drilled Aqueduct Mesa, the electric log does not universally reflect the top of zeolitization within holes drilled Rainier Mesa. This report, the final in a trilogy of reports dealing with rock properties interpreted chiefly from geophysical logs, examines the electrical measurement obtained in 33 vertical drill holes in the Rainier Mesa area, Nevada. 85 refs., 36 figs., 8 tab.

32718 **On the structure of carbon films deposited on Si(111) by mass-selected low energy C^+ beams.** Robertson, J.L. (Physics Dept., Univ. of Houston, Houston, TX (US)); Jiang, X.G.; Chow, P.C.; Moss, S.C.; Lifshitz, Y.; Kasi, S.R.; Rabalais, J.W.; Adar, F. 9-14 of Optical materials. Poker, D.B.; Ortiz, C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8904283–: Optical materials: processing and science, San Diego, CA (USA), 24-26 Apr 1989).

The authors' recent report of epitaxial single crystal growth of C_+ ion-beam-deposited diamond films on (111) single crystals of silicon is shown to be incorrect. The authors briefly describe the circumstances leading to this revision (and to our earlier finding) and discuss the possible structure of these films based on preliminary synchrotron x-ray data and on the Raman spectrum.

32719 **Structural and chemical imaging of superconductors and semiconductors by high-resolution STEM.** Pennycook, S.J. (Solid State Division, Oak Ridge National Lab., Oak Ridge, TN (US)). 39-44 of High resolution microscopy of materials. Krakow, W.; Ponce, F.A.; Smith, D.J. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-8811196–: MRS symposium on high resolution microscopy of materials, Boston, MA (USA), 29 Nov - 1 dec 1988).

In this paper a new method for high-resolution imaging of a crystal lattice is presented, based on high-angle electron scattering in a scanning transmission electron microscope (STEM). An electron probe of atomic dimensions is canned over the sample and the electron flux scattered through large angles measured by an annular detector and used to form an image. The detector integrates over a large range of angles and therefore replaces the coherent phase contrast of conventional high resolution TEM with the strong atomic number or Z-contrast characteristic of high angle Rutherford scattering. These characteristics make the image entirely complementary to the conventional image, ideal for studying the atomic structure and chemistry of defects and interfaces. Examples of the high $T_c$superconductors, epitaxial Ge on Si, and $Si_{1-x}Ge_x$/Si strained layer superlattices are shown, and a simple approximate method of image simulation is presented.

32720 **Chemisorption of HF on silicon surfaces.** Joyce, S.A. (Surface Science Div, National Institute of Standards and Technology, Gaithersburg, MD (US)); Yarmoff, J.A.; Johnson, A.L.; Madey, T.E. 185-190 of Chemical perspectives of microelectronic materials. Gross, M.E.; Jasinski, J.M.; Yates, J.T. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811223–: Chemical perspectives of microelectronic materials, Boston, MA (USA), 30 Nov - 2 dec 1988).

The authors have investigated the interaction of gaseous hydrofluoric acid (HF) with single crystal silicon surfaces using x-ray photoemission spectroscopy and electron stimulated desorption ion angular distributions (ESDIAD). Examination of the Si(2p) core level for surfaces saturated with HF shows the formation of silicon-fluoride bonds indicating the dissociative chemisorption of HF on both Si(111) and Si(100) surfaces. Inspection of the F(2s) and F(2p) valence levels at saturation coverage indicate that only one-half monolayer of fluorine bonds to the silicon. The primary ion desorbed by electron bombardment of these surfaces is F^+ with only a minor contribution from H^+ ESDIAD images from a saturation coverage of HF on stepped Si(100) surfaces reveal F^+ desorption primarily along the direction of the terrace dimers. The ESDIAD patterns from HF adsorbed on Si(111) are characterized by strong normal F^+ emission with a weak background component of off-normal emission. These results are consistent with the dissociative chemisorption of HF where the ion emission direction is determined by the Si-F bond directions.

32721 **Application of x-ray scattering to the in situ study of organometallic vapor phase epitaxy.** Fuoss, P.H. (AT and T Bell Lab, Holmdel, NJ (US)); Kisker, D.W.; Brennan, S.; Kahn, J.L. 137-142 of Chemical perspectives of microelectronic materials. Gross, M.E.; Jasinski, J.M.; Yates, J.T. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC03-82ER13000. (CONF-8811223–: Chemical perspectives of microelectronic materials, Boston, MA (USA), 30 Nov - 2 dec 1988).

Despite their importance, the detailed surface reactions and rearrangements which occur during chemical deposition remain largely undetermined because of the lack of suitable experimental probes. In principle, x-ray scattering and spectroscopy techniques are well suited to studying these near atmospheric pressure processes but advances in this area have been limited both by the lack of suitable x-ray sources and by the difficulty of integrating the growth and measurement experiments. The authors have developed equipment and techniques to perform in situ x-ray scattering studies of the structure of surfaces during organometallic vapor phase epitaxial (OMVPE) growth using the extremely bright undulator radiation from the PEP electron storage ring. In this paper, they describe initial experimental results studying cleaning and subsequent reconstruction of GaAs (001) surfaces in a flowing H_2 ambient. These results demonstrate the excellent surface sensitivity, low background and high signal levels necessary to study the dynamic processes associated with semiconductor growth using OMVPE.

32722 **Adsorption and decomposition of trimethylarsenic on GaAs (100).** 240Creighton, J.R. (Sandia National Lab, Div 1126, Albuquerque, NM (US)). 129-135 of Chemical perspectives of microelectronic materials. Gross, M.E.; Jasinski, J.M.; Yates, J.T. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC04-76DP00789. (CONF-8811223–: Chemical perspectives of microelectronic materials, Boston, MA (USA), 30 Nov - 2 dec 1988).

Alkylated arsenic compounds have shown some promise as alternatives to arsine as the group-V source gas for GaAs MOCVD. However, little is known about the fundamental chemical interactions of these compounds with the GaAs surface. The authors report their investigation of the adsorption and reactivity of trimethylarsenic (TMAs) on GaAs(100) using temperature programed desorption (TPD), Auger electron spectroscopy, and LEED. For the exposures and temperatures studied, TMAs did not pyrolytically decompose on the GaAs(100). TPD results indicate that TMAs chemisorbs, apparently non-dissociatively, and desorbs $\simeq$ 330 K. Multilayers of TMAs desorb $\simeq$ 140-160 K. Exposure of adsorbed TMAs to 70 eV electrons results in irreversible decomposition of the molecule. After electron irradiation, TPD shows that

methyl radicals desorb at 660 K, which corresponds to a desorption activation energy of $\simeq$ 40 kcal/mol. At higher temperatures, As_2, H_2, C_2H_2, and a smaller amount of methyl radicals desorb, and a small coverage of carbon remains on the surface.

32723 **Correlation between optical absorption and refractive index of silica and silicate glasses implanted with copper.** Weeks, R.A. (Vanderbilt Univ., Nashville, TN (USA)); Magrudev, R.; Hosono, H.; Zuhr, R.; Mogul, H. 115-120 of Optical materials. Poker, D.B.; Ortiz, C. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-8904283–: Optical materials: processing and science, San Diego, CA (USA), 24-26 Apr 1989).

The refractive indices and optical absorptions of Cu implanted glasses have been measured. Silica and two silicate glasses have been implanted with Cu_+ to nominal doses ranging from 3 x $10^{15}cm^{-2}$ to 6 x $10_{16}cm^{-2}$ at an energy of 160KeV and currents of $\sim$ 4 μAcm^{-2} Substrate temperatures, during implantation, ranged from $\sim$ 100 K to 700 K. Both refractive index and optical absorption of the silica are functions of dose and substrate temperature. Neither of these properties are significantly altered in the silicate glasses for any dose or substrate temperature. The observed increases in the index of the implanted silica are attributed to an optical band due to Cu^0 colloids.

32724 **Defect reduction in MOCVD grown Si/GaAs.** Al-Jassim, M.M. (Solar Energy Research Inst., Golden, CO (USA)); Nishioka, T.; Yamamoto, A.; Yamaguchi, M. 141-146 of Heteroepitaxy on silicon: Fundamentals, structure, and devices. Choi, H.K.; Hull, R.; Ishiwara, H.; Nemanich, R.J. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804299–: Heteroepitaxy on silicon: fundamentals, structure, and devices, Reno, NV (USA), 5-8 Apr 1988).

This paper reports a study of the effectiveness of thermal annealing and strained layer superlattices (SLS's) in defect reduction in Si/GaAs structures. The GaAs layers were grown on (100) Si substrates by low pressure MOCVD. They were evaluated by TEM, HREM, EBIC and PL. As-grown layers contained dislocation densities in the 10^8–10^9 cm^{-2} range, depending on the layer thickness. Post-growth and in situ annealing were performed on a wide variety of these structures. TEM examination shows that in situ annealing was more effective as it resulted in confining a large portion of the threading dislocations to the interface region. Furthermore, the interaction of threading dislocations to form closed loops was evident. Additionally, the effect of GaAs/GaInAs and GaInAs/GaAsP SLS's on dislocation bending was investigated. The former SLS, although not lattice matched to GaAs, proved more effective. Capacitance transient spectroscopy has been applied to identify deep levels associated with heteroepitaxial GaAs grown on silicon. Results from p^+n diode test structures reveal creation of the electron trap EL2 and a high density of hole states in the bandgap. This is the first reported observation of hole traps in MBE GaAs on Si. The activation behavior of the electron and hole signal peaks fits the signature of two different charge states associated with EL2, a native point defect complex seen in MOCVD, VPE, and bulk-grown GaAs, but not usually observed in MBE grown GaAs. The spectra seen show many similarities with earlier deep level transient spectroscopy (DLTS) observations on plastically deformed GaAs.

32725 **In situ HVEM study of ion irradiation-induced grain growth in Au thin films.** Liu, J.C. (Cornell Univ., Ithaca, NY (USA). Dept. of Materials Science and Engineering); Li, J.; Mayer, J.W.; Allen, C.W.; Rehn, L.E. 297-302 of Processing and characterization of materials using ion beams. Rehn, L.E.; Greene, J.; Smidt, F.A. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-8811225–: Processing and characterization of materials using ion beams, Boston, MA (USA), 28 Nov - 2 dec 1988).

In situ observations of 1.5 MeV Xe^+ ion irradiated Au films at room temperature and at 150°C reveal the evolution of grain growth. The average grain size increases by the mechanisms of grain boundary migration and grain coalescence.

32726 **Deposition of dielectric optical coatings: A microstructural study of the deposited layers and interfaces.** McCarthy, J.M. (Pacific Northwest Lab., Battelle Memorial Institute, Richland, WA (US)); Thomas, L.E.; Pawlewicz, W.T.; Frydrych, W.S.; Exarhos, G.J. 201-208 of Optical materials. Poker, D.B.; Ortiz, C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8904283–: Optical materials: processing and science, San Diego, CA (USA), 24-26 Apr 1989).

Thin dielectric films for optical applications are deposited on substrates using a variety of techniques including reactive sputtering, solgel reaction, and ion assisted plasma deposition. This transmission electron microscopy study characterizes optical coatings produced by the above deposition techniques and shows how changes in deposition conditions change microstructure and as a result the optical properties.

32727 **Linear free energy relationships in glass corrosion.** Abrajano, T.A. (Argonne National Lab., Argonne, IL (US)); Bates, J.K.; Bohlke, J.K. 253-262 of Materials issues in art and archaeology. Sayre, E.V.; Vandiver, P.; Sruzik, J.; Stevenson, C. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract W-31-109-ENG-38. (CONF-8804301–: Materials issues in art and archaeology, Reno, NV (USA), 6-8 Apr 1988).

Various theoretical models that have been proposed to correlate glass durability to their composition for a wide variety of silicate, borosilicate, and aluminosilicate glasses are examined. Comparisons are made between the predictions of these models and those of an empirical formulation extracted from existing data in the present work. The empirical approach provides independent confirmation of the relative accuracy of the silica release rate predictions of the different theoretical models in static leaching systems. Extensions of the empirical approach used in this work are discussed.

32728 **Radiation effects in silicate glasses: A review.** Bibler, N.E. (E.I. du Pont de Nemours and Co., Savannah River Lab, Aiken, SC (US)); Howitt, D.G. 263-284 of Materials stability and environmental degradation. Barkatt, A.; Verink, E.D. Jr.; Smith, L.R. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract AC09-76SR00001;FG03-86ER45279. (CONF-8804134–: Symposium on materials stability and environmental degradation, Reno, NV (USA), 5-9 Apr 1988).

The study of radiation effects in complex silicate glasses has received renewed attention because of their use in special applications such as high level nuclear waste immobilization and fiber optics. Radiation changes the properties of these glasses by altering their electronic and atomic configurations. These alterations or defects may cause dilatations or microscopic phase changes along with absorption centers that limit the optical application of the glasses. Atomic displacements induced in the already disordered structure of the glasses may affect their use where heavy irradiating particles such as alpha particles, alpha recoils, fission fragments, or accelerated ions are present. Large changes (up to 1%) in density may result. In some cases the radiation damage may be severe enough to affect the durability of the glass in aqueous solutions. In the paper, the authors review the literature concerning radiation effects on density, durability, stored energy, microstructure and optical properties of silicate glasses. Both simple glasses and complex glasses used for immobilization of nuclear waste are considered.

32729 **The photoluminescence and TEM studies of patterned GaAs films on Si substrate grown by molecular beam epitaxy.** Lee, H.P. (California Univ., Berkeley, CA (USA)); Huang, Y.H.; Liu, X.; Lin, H.; Smith, J.S.; Weber, E.R.; Yu, P.; Wang, S.; Lilintal-Weber, Z. 219-226 of Heteroepitaxy on silicon: Fundamentals, structure, and devices. Choi, H.K.; Hull, R.; Ishiwara, H.; Nemanich, R.J. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract AC03-76SF00098. (CONF-8804299–: Heteroepitaxy on silicon: fundamentals, structure, and devices, Reno, NV (USA), 5-8 Apr 1988).

Patterned epitaxial GaAs films have been formed on Si substrates by either growth over patterned substrate selective-area epitaxy or chemical etching of patterns after growth. The optical properties of these samples are studied by 77 K photoluminescence (PL) and the defect structures are investigated by transmission electron microscope (TEM). The patterned substrate consisted of bare Si stripes with width ranging from 10 μm to 100 μm surrounded by Si_3N_4 films on both sides and a reference area of bare Si. For 1.5 μm and 3μm thick films, PL intensities from the

films inside the 10 μm stripe shows 140% and 75% increase over unpatterned areas while the residual tensile stress in the patterned films is very similar to that of the unpatterned area. The increase in the photoluminescence intensity is ascribed to the reduction of crystalline defects inside the window area. In the chemically etched sample, the pattern consisted of 4 μm by 4 μm squares and 1 mm long stripes with widths ranging from 100 μm to 4 μm. From the shift of PL peaks, a monotonic decrease in the tensile stress versus stripe width is observed. In particular, when the width of the stripe is less than 7 μm, tensile stress becomes essentially uniaxial in agreement with the results obtained on a GaAs on InP sample. The polarization of the luminescence spectra parallel and perpendicular to the uniaxial stress of a 4 μm wide stripe agrees well with theoretical prediction. It is also observed that tensile stress is almost completely relieved in the 4 μm by 4 μm etched squares.

32730 Precipitation of Ar, Kr and Xe in Ni at room temperature. Liu, A.S. (Materials Science Div., Argonne National Lab., Argonne, IL (US)); Birtcher, R.C. 303-308 of Processing and characterization of materials using ion beams. Rehn, L.E.; Greene, J.; Smidt, F.A. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-8811225--: Processing and characterization of materials using ion beams, Boston, MA (USA), 28 Nov - 2 dec 1988).

Transmission electron microscopy (TEM) has been used to study the precipitation of inert gases (Ar, Kr and Xe) injected into Ni at room temperature. The nucleation and size distribution of precipitates were found to be insensitive to the type of inert gas atom but dependent on gas concentration (ion fluence). The precipitate density decreases and the sizes increases with increasing gas concentration. In all cases, the inert gases precipitate as solid fcc crystals with their axes aligned with those of the host Ni lattice. For the same inert gas concentration, the lattice parameter is larger for the higher atomic mass in accord with bulk results. The lattice parameter of each type of inert gas precipitate increases with increasing gas concentration owing to the pressure relaxation that accompanies precipitate growth. This results in melting of large precipitates in accord with the behavior of bulk quantities of the gases at low temperatures.

32731 Novel method for constructing tetrahedral frames. Gilman, J.J. (Center for Advanced Materials, Lawrence Berkeley Lab, Univ of California, Berkeley, CA (US)). 369-378 of High temperature/high performance composites. Lemkey, F.D.; Strife, J.R.; Fishman, S.G.; Evans, A.G. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract AC03-76SF00098. (CONF-8804181--: MRS: high temperature/high performance composites, Reno, NV (USA), 5-9 Apr 1988).

This paper is concerned with the design and construction of a frame that makes optimal use of modern materials together with optimal structural design. It is modular in format and can be constructed using puckered rings which combine to make a frame with tetrahedral nodes and cubic symmetry; analogous with the crystal structure of diamond. This frame can be extended indefinitely in three dimensions by adding modules to its core. Such a frame has high capacity to bear loads relative to its weight. For some types of loading it has the highest possible specific-structural strength (for a frame of struts). It is a structural analog of a foam. The frame described here uses continuous puckered rings as strut-like members. These rings provide maximum structural efficiency, and can be readily constructed from materials that have maximal specific stiffnesses and strengths, including filamentary composites.

32732 A new tool for cellulose degradation studies. Windisch, D.E. (Northrop Research and Technology Center, Palos Verdes, Peninsula, CA (US)); Long, W.H.; Stappaerts, E.A.; Jackson, J.P.; Arthurs, E.; Schwalbe, L.A.; Sega, R.M. 311-316 of Materials issues in art and archaeology. Sayre, E.V.; Vandiver, P.; Sruzik, J.; Stevenson, C. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804301--: Materials issues in art and archaeology, Reno, NV (USA), 6-8 Apr 1988).

The authors describe a new technique for studying thermally-induced chemical transformations in cellulose. The apparatus consists of a carbon dioxide laser for heating, an infrared thermometer, and an optical reflectance spectrometer. To illustrate the technique, the authors present measurements from a single piece of sample linen along five isotherms in the range 200–290°C. The results are discussed in terms of first-order chemical rate theory and a four-step model. From the measurements the authors derive the activation energies. Arrhenius constants, and reflectivities of the chromophoric states.

32733 GaP/Si heteroepitaxial layers with reduced defect density. Blakeslee, A.E. (Solar Energy Research Inst., Golden, CO (USA)); Al-Jassim, M.M.; Olson, J.M.; Jones, K.M.; Vernon, S.M. 313-318 of Heteroepitaxy on silicon: Fundamentals, structure, and devices. Choi, H.K.; Hull, R.; Ishiwara, H.; Nemanich, R.J. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract AC02-83CH10093. (CONF-8804299--: Heteroepitaxy on silicon: fundamentals, structure, and devices, Reno, NV (USA), 5-8 Apr 1988).

It is shown that GaP layers grown upon Si at a single temperature of 900°C can have a crystalline quality superior to that exhibited by previous two-step and one-step growth methods. The layers are characterized by a planar network of MISFIT dislocations confined to the interface plane and a reduced density of threading dislocations (low 10^6 cm^{-2}; previously . 10^8). Very few threading defects were observed in areas devoid of amorphous oxide contamination, as shown by HREM examination of cross-sectional samples. A low growth rate during nucleation enhances crystalline perfection, since it decreases the tendency toward three-dimensional islanding.

32734 Microstructural studies of IAD and PVD Cr coatings by cross section transmission electron microscopy. Cheng, C.C. (Materials and Components Technology Div., Argonne National Lab., Argonne, IL (US)); Evck, R.A.; Fenske, G.R. 445-450 of Processing and characterization of materials using ion beams. Rehn, L.E.; Greene, J.; Smidt, F.A. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-8811225--: Processing and characterization of materials using ion beams, Boston, MA (USA), 28 Nov - 2 dec 1988).

This paper reports cross section transmission electron microscopy used to study the microstructure and interface structure of Cr films deposited by ion-assisted deposition as a function of the incident ion energy. High-energy ion bombardment (1 keV) was found to enhance the adhesion of the deposited film owing to the formation of an intermixed layer, whereas deposition with low-energy ions (100 eV) was found to reduce or eliminate grain boundary porosity. A tailored Cr film with excellent adhesion and no grain boundary porosity was deposited by combining high- and low-energy ion bombardment.

32735 A comparison between energetics of decomposition and photo-deposition of Pd and Pt from $Pd(C_5H_5)(C_3H_5)$ and $Pt(C_5H_5)$. Stauf, G.T. (Lab. for Solid State Science and Technology, Syracuse Univ., Syracuse, NY (US)); Dowben, P.A.; Birge, R.R.; Emrich, K.H.; Hirshwald, W.; Barfuss, S.; Boag, N.M. 401-406 of Chemical perspectives of microelectronic materials. Gross, M.E.; Jasinski, J.M.; Yates, J.T. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811223--: Chemical perspectives of microelectronic materials, Boston, MA (USA), 30 Nov - 2 dec 1988).

The energetics of decomposition of variety of organometallic compounds have been determined from photoionization mass spectroscopy and electron impact mass spectroscopy. In particular, $Pd(C_5H_5)(C_3H_5)$ and $Pt(C_5H_5)(C_3H_5)$ have been studied in this fashion, and the information used to make patterned Pd/Ni/Si heterostructures by laser induced photolysis of the palladium compound and nickelocene in vacuum (MOCVD). Contamination in the thin films was determined by Auger electron spectroscopy, and compared with that found by other researchers for photo-deposition of Pt from the cylopentadiene allyl. Thermodynamic data is used to explain differing contamination levels in the Pd and the Pt coatings.

32736 Chemical bonding and lattice mismatch in semiconductor-insulator heteroepitaxy: SrFsub 2on Si(111). Olmstead, M.A. (California Univ., Berkeley, CA (USA). Dept. of Physics); Bringans, R.D. 419-424 of Heteroepitaxy on silicon: Fundamentals, structure, and devices. Choi, H.K.; Hull, R.; Ishiwara, H.; Nemanich, R.J. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804299--: Heteroepitaxy on silicon: fundamentals, structure, and devices, Reno, NV (USA), 5-8 Apr 1988).

The growth of SrF_2 on Si(111) is investigated using photoemission spectroscopy and compared to the growth of CaF_2 on Si(111). Both CaF_2 and SrF_2 have a fluorite lattice structure closely related to silicon's diamond lattice structure. However, while the room temperature lattice constant of Si is only 0.6% smaller than that of CaF_2, it is 6.8% smaller than that of SrF_2. The photoemission results for thin films of SrF_2 on Si(111) are very similar to previous measurements of the CaF_2-on Si(111) interface, reflective of strong silicon-cation bonding and the removal of fluorine from the interface. These results indicate that the chemical and electronic driving forces to dissociate the CaF_2 or SrF_2 molecule at the fluoride-silicon interface dominate over the structural constraints induced by the lattice mismatch.

32737 Electrical and structural properties of $TiSi_2$ films. Ravindra, N.M. (Dept. of Physics, New Jersey Institute of Technology, Newark, NJ (US)); Fink, T.; Moerkirk, R.P.; Fathy, D. 459-464 of Heteroepitaxy on silicon: Fundamentals, structure, and devices. Choi, H.K.; Hull, R.; Ishiwara, H.; Nemanich, R.J. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804299–: Heteroepitaxy on silicon: fundamentals, structure, and devices, Reno, NV (USA), 5-8 Apr 1988).

Studies of the electrical and structural properties of $TiSi_2$ films formed during the fabrication of shallow junctions by ion implanting As^+ into p-Si through Ti films are reported. Electrical measurements of the temperature dependent specific contact resistance and structural measurements such as transmission electron microscopy have been performed on these device structures. The specific contact resistance is seen to decrease with increasing measurement temperature. These studies have been carried out on furnace and rapid thermally annealed films.

32738 Metastability in SiGe/Si strained-layer structures. Dodson, B.W. (Sandia National Labs., Albuquerque, NM (USA)). 491-504 of Heteroepitaxy on silicon: Fundamentals, structure, and devices. Choi, H.K.; Hull, R.; Ishiwara, H.; Nemanich, R.J. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract AC04-76DP00789. (CONF-8804299–: Heteroepitaxy on silicon: fundamentals, structure, and devices, Reno, NV (USA), 5-8 Apr 1988).

The physics governing growth and stability properties in SiGe/Si strained-layer structures is reviewed. The role of metastability in crystal growth is outlined. Experimental data on stability limits and rates of strain relaxation are examined. The authors conclude that essentially all observations on relaxation of semiconductor strained-layer structures can be explained by standard models of plastic deformation adapted to the special conditions controlling dislocation dynamics in these structures.

32739 Pyrolytic and laser photolytic growth of crystalline and amorphous germanium films digermane (Ge_2H_6). Eres, D. (Solid State Div., Oak Ridge National Lab, Oak Ridge, TN (US)); Lowndes, D.H.; Tischler, J.Z.; Sharp, J.W.; Geohegan, D.B.; Pennycook, S.J. 517-522 of Chemical perspectives of microelectronic materials. Gross, M.E.; Jasinski, J.M.; Yates, J.T. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-8811223–: Chemical perspectives of microelectronic materials, Boston, MA (USA), 30 Nov - 2 dec 1988).

This paper reports on high-purity digermane (Ge_2H_6, 5% in He) used to grow epitaxially oriented crystalline Ge films by pyrolysis. Amorphous Ge.H films also have been deposited by pyrolysis and ArF(193nm) laser-induced photolysis. The amorphous-to-crystalline transition and the film's morphology was studied as a function of deposition conditions. The film's microstructure, strain and epitaxial quality were assessed using x-ray diffraction curves and scanning and transmission electron microscopy. It was found that commensurate, coherently strained epitaxial Ge films could be grown pyrolytically on (100) GaAs at low (0.05-40 m Torr) Ge_2H_6 partial pressures, for substrate temperatures above 380°C.

32740 Damage formation in semiconductors during MeV ion implantation. Sjoreen, T.P. (Solid State Div., Oak Ridge National Lab., Oak Ridge, TN (US)); Holland, O.W.; El-Ghor, M.K.; White, C.W. 593-598 of Processing and characterization of materials using ion beams. Rehn, L.E.; Greene, J.; Smidt, F.A. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-8811225–: Processing and characterization of materials using ion beams, Boston, MA (USA), 28 Nov - 2 dec 1988).

Damage produced by 1.0-2.5 MeV self-ion and O-ion implantation into Si and Ge single crystals has been characterized by cross-sectional electron microscopy and ion channeling. In Si, it is observed that the damage morphology varies substantially along the ion's track. Near the end-of- range of the ion, damage accumulation is very similar to that which occurs during medium- to low-energy implantation (i.e., damage increases monotonically with dose until the lattice is made completely amorphous). In front of this end-of-range region, however, damage saturates at a very low level for moderate implantation fluences. A model based on homogeneous damage nucleation in Si is discussed. For Ge, damage accumulation is very different; a monotonic increase of damage with dose is observed over the entire range of the ion. Possible mechanisms responsible for the differences between Si and Ge are discussed.

32741 Electronic properties of Si-Ge micro nipi structures. Yang, L.H. (Dept. of Physics, Univ., of California, CA (US)); Fong, C.Y.; Nelson, J.S. 513-518 of Heteroepitaxy on silicon: Fundamentals, structure, and devices. Choi, H.K.; Hull, R.; Ishiwara, H.; Nemanich, R.J. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804299–: Heteroepitaxy on silicon: fundamentals, structure, and devices, Reno, NV (USA), 5-8 Apr 1988).

In this paper, the authors present the electronic properties of the micro nipi structures with Aluminum(Al) and Arsenic(As) as dopants in a $(Si)_{10}$-Ge_2 [001] superlattice grown on a Si substrate, where the subscript indicates the number of atomic layers. The Ge region is treated as one of the insulating layers, while the other insulating region will be the undoped Si layers. Two different configurations of Al and As with respect to the Ge region are considered.

32742 A time-resolved x-ray scattering technique for observation of non-equilibrium phonons. Chapman, L.D. (National Synchrotron Light Source, Brookhaven National Lab, Upton, New York 11973 (US)); Ehrlich, S.N.; Lazarz, N.M. *Review of Scientific Instruments (USA)*, 61(1): 86-89 (Jan 1990). DOE Contract FG02-85ER45183;AC02-76CH00016.

We have demonstrated a time-resolved x-ray diffraction technique for observing nonequilibrium phonons. We have used this technique to observe phonons in α-quartz at low temperatures. Phonons were generated by direct stimulation of near zone center transverse-optical phonons using infrared light from a powerful Q switched CO_2 laser. We show data taken at a Brillouin zone boundary confirming the presence of nonequilibrium phonons initially generated by the laser and their resulting decay products.

32743 A new method for analyzing data from continuous depth-sensing microindentation tests. Joslin, D.L. (Metals & Ceramics Division, Oak Ridge National Laboratory, P. O. Box 2008, Oak Ridge, Tennessee 37831-6118 (US)); Oliver, W.C. *Journal of Materials Research (USA)*, 5(1): 123-126 (Jan 1990). DOE Contract AC05-84OR21400.

A new parameter, hardness/modulus^2 (H/E^2), has been derived from the equations used to calculate the hardness and elastic modulus from data taken during continuous depth-sensing microindentation tests. This paper discusses the use of this parameter to treat the data obtained from a sample whose surface roughness was of the same scale as the size of the indents. The resulting data were widely scattered. This scatter was reduced when the data were plotted in terms of H/E^2 versus stiffness. The effect of surface roughness on the hardness and elastic modulus results is removed via stiffness measurements, provided single contacts are made between the indenter and the specimen. The function relating the cross-sectional area of the indenter versus the distance from its point is not required for calculation of H/E^2, but the hardness and modulus cannot be determined separately. The parameter H/E^2 indicates resistance to plastic penetration in this case.

32744 The hydrogenated amorphous silicon reach-through avalanche photodiodes (a-Si:H RAPD's). Hong, J.W. (Semiconductor and System Labs., National Chen Kung Univ., Tainan, Taiwan (TW)); Chen, Y.W.; Laih, W.L.; Fang, Y.K.; Chang, C.Y.;

Gong, C. *IEEE Journal of Quantum Electronics (Institute of Electrical and Electronics Engineers) (USA),* 26(2): 280-310 (Feb 1990).

This paper describes the RAPD structure. The RAPD structure is adopted to improve the electrical and optical performance of the photosensing device made of a-Si:H. Both the electron-injection n^+-i-δp-i-p^+ and hole-injection p^+-i-δn-i-n^+ a-Si:H RAPD's are fabricated on the ITO-coated glass substrates by plasma enhanced chemical vapor deposition (PECVD) system. The photocurrent multiplication method is employed to study the multiplication factors and the impact ionization coefficients of the a-Si:H RAPD's. Since the electron-injection models have better performance, the relationships between the device dimensions and characteristics, such as *I-V* curves, optical gains, impact ionization rates, and excess noise factors are further studied and presented.

32745 Composition and structure of native oxide on silicon by high resolution analytical electron microscopy. Kim, M.J. (Center for Solid State Science, Arizona State University, Tempe, Arizona 85287-1704 (USA)); Carpenter, R.W. *Journal of Materials Research (USA),* 5(2): 347-351 (Feb 1990). DOE Contract FG02-87ER45305.

Compositional analysis of thin nanoscale native oxide films formed on {001} silicon wafer surfaces at room temperature was done with an electron energy loss spectrometer coupled to an analytical electron microscope having a field emission source, with better than 4 nm spatial resolution. The electron energy loss spectra show a shift in the threshold onset energy of the Si-L edge of the native oxide from ~99 eV loss corresponding to pure elemental silicon to ~105 eV loss, and elemental analysis using the ionization regions of the core loss edges showed the composition to be SiO, within a few percent. Microdiffraction and high resolution electron microscopy (HREM) results showed that the native oxide was completely amorphous, and did not contain detectable nanocrystals. The native oxide can be removed from the Si surface by heating in UHV for a short time at 1000 °C. However, this procedure resulted in the formation of small amounts of a crystalline phase on the Si wafer surface, which was shown to be β-SiC by the same methods.

32746 Structural characterization of damage in Si(100) produced by MeV Si^+ ion implantation and annealing. El-Ghor, M.K. (Oak Ridge National Laboratory, Solid State Division, Oak Ridge, Tennessee 37831 (USA)); Holland, O.W.; White, C.W.; Pennycook, S.J. *Journal of Materials Research (USA),* 5(2): 352-359 (Feb 1990). DOE Contract AC05-84OR21400.

Buried amorphous layers were produced by implantation of MeV Si^+ ions in silicon single crystal at room temperature and liquid nitrogen temperature. The damage is characterized structurally both in the as-implanted condition and after post-implantation furnace annealing. Growth of the amorphous layer during room temperature implantation is found to occur by a layer-by-layer mechanism with relatively sharp interfacial transition regions. A wide region ahead of the buried amorphous region extending to the surface is observed to be free of any extended defects. Recrystallization of the damaged region during thermal annealing occurs by solid-phase epitaxial growth at both interfaces. A lower growth velocity is found at the upper interface, which is attributed to a higher hairpin dislocation density grown-in at this interface. Results of irradiation at liquid nitrogen temperature, on the other hand, show that nucleation and growth of the amorphous damage occurs over a wide region and is not confined to the interfacial region. This results in a very diffuse upper interface composed of a mixture of amorphous and crystalline phases. Substantial reordering is observed in this mixed-phase region after 400 °C annealing, even though this temperature is too low for normal interfacial solid-phase epitaxial growth. Cross-sectional transmission electron microscopy, as well as Rutherford backscattering spectroscopy, were used in this study.

32747 Comment on "Observation and structural determination of $\sqrt{3}\times\sqrt{3}$ $R30°$ reconstruction of the Si(111) surface". Chan, C.T. (Ames Laboratory-U.S. Department of Energy, Ames, IA (US)—Department of Physics, Iowa State University, Ames, IA 50011 (US)—Microelectronic Research Center Department of Physics, Iowa State University, Ames, IA 50011 (US)); Ho, K.M. *Physical Review Letters (USA),* 64(4): 491 (22 Jan 1990). DOE Contract W-7405-ENG-82.

A Comment on the Letter by W. C. Fan *et al.*, Phys. Rev. Lett. 62, 1516 (1989).

32748 Laser damage studies of ZnS via neutral Zn particle emission. Arlinghaus, H.F. (Argonne National Laboratory, Argonne, Illinois 60439 (US)); Calaway, W.F.; Young, C.E.; Pellin, M.J.; Gruen, D.M.; Chase, L.L. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 436-438 (20 Oct 1989). DOE Contract W-31-109-ENG-38;W-7405-ENG-48. (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

Emission of neutral atoms from ZnS surfaces due to laser irradiation has been observed at power densities two orders of magnitude below the single pulse damage threshold of the material. We have measured the velocity distribution and absolute yield of neutral Zn atoms generated by exposure of ZnS single crystals to XeCl excimer laser irradiation (308 nm) using time-of-flight and high-resolution two-photon laser-induced fluorescence spectroscopy. The distributions are in agreement with Maxwell-Boltzmann distributions. The characteristic temperature increases from 2000 to 9000 K as the fluences are raised from 17 to 80 mJ/cm^2, respectively. The absolute Zn yield also increased from 10^8 to 10^{12} atoms per laser pulse as the laser fluence is increased. The insults suggest formation of a plasma that interacts with the surface and leads to catastrophic failure. For consecutive laser shots at constant lasers fluences, a nearly exponential increase in the Zn particle density is observed, yet visible damage did not occur until 150,000 laser shots. Our results show that neutral particle emission is of considerable importance in the identification of fundamental damage mechanisms and that microscopic damage occurs far below the single-pulse damage threshold.

32749 Evidence that similar point defects cause 1/*f* noise and radiation-induced-hole trapping in metal-oxide-semiconductor transistors. Fleetwood, D.M. (Sandia National Laboratories, Division 2147, Albuquerque, New Mexico 87185-5800 (US)); Scofield, J.H. *Physical Review Letters (USA),* 64(5): 579-582 (29 Jan 1990). DOE Contract AC04-76DP00789.

We have found that the 1/*f*-noise magnitude of unirradiated metal-oxide-semiconductor (MOS) transistors correlates strikingly with the radiation-induced-hole trapping efficiency of the oxide (f_{OT}). This suggests that the previously unidentified defect that causes 1/*f* noise in MOS transistors is linked to the radiation-induced-hole trap, the "*E'* center," or to a direct precursor (likely a simple oxygen vacancy) known to be present in SiO_2 before irradiation. We derive a simple equation that relates the noise and f_{OT}.

32750 Band-gap narrowing in ordered and disordered semiconductor alloys. *Applied Physics Letters (USA),* 56(7): 662-664 (12 Feb 1990). DOE Contract AC02-77CH00178.

Either spontaneous or artificial ordering of semiconductor alloys into CuAu-like, chalcopyrite, or CuPt-like structures is predicted to be accompanied by a reduction in the direct band gaps relative to the average over the binaries. In this letter calculated results are presented for seven III-V and II-VI alloys. We identify the mechanism for this band-gap narrowing as band folding followed by repulsion between the folded states. The latter is coupled by the non-zinc-blende component of the superlattice potential. The same physical mechanism (but to a different extent) is responsible for gap bowing in *disordered* alloys.

32751 Anomalous copper diffusion through samarium. Wieliczka, D.M. (University of Missouri - Kansas City, Kansas City, Missouri 64110 (US)); Olson, C.G. *Journal of Vacuum Science and Technology, A (Vacuum, Surfaces and Films) (USA),* 8(2): 891-894 (Mar 1990). DOE Contract W-7405-ENG-82.

We report the observation of enhanced diffusion of Cu through thick films of Sm at temperatures of 250–300 K. The rate of diffusion of Cu to the surface is found to be independent of temperature. The time dependence of the intensities of the Sm divalent and trivalent features indicate the Cu occupies interstitial sites below the divalent Sm surface layer and above the trivalent Sm bulk. The measured binding energies of the divalent and trivalent Sm show no shift with respect to pure Sm, indicating the Cu does not react with the Sm. The spectral features associated with Cu indicate it is

in an atomic-like configuration. An examination of these intensities also provide evidence for heterogeneous mixed valence in Sm.

32752 Nucleation of amorphous germanium from supercooled melts. Stiffler, S.R. (Department of Materials Science and Engineering, Cornell University, Ithaca, New York 14853 (USA)); Thompson, M.O.; Peercy, P.S. *Applied Physics Letters (USA),* 56(11): 1025-1027 (12 Mar 1990). DOE Contract AC04-76DP00789.

Thin germanium films on SiO_2 completely melted by pulsed laser irradiation cool rapidly by thermal conduction to the substrate until they solidify. *In situ* measurements indicate that the liquid is supercooled by 420–530 K with respect to the crystalline phase prior to solidification. Cross-sectional transmission electron microscopy reveals nucleation events at the Ge/SiO_2 interface. The microstructure of these events is comprised of a very fine grained (5–15 nm) polycrystalline core with much larger grains extending laterally and toward the free surface. It is believed that nucleation of the amorphous phase, which was subsequently converted to the fine-grained material, initiated solidification.

32753 Molecular beam epitaxy regrowth by use of ammonium sulfide chemical treatments. Melloch, M.R. (School of Electrical Engineering, Purdue University, West Lafayette, Indiana 47907 (US)); Carpenter, M.S.; Dungan, T.E.; Li, D.; Otsuka, N. *Applied Physics Letters (USA),* 56(11): 1064-1066 (12 Mar 1990). XL-5-05018-1.

The application of ammonium sulfide chemical treatments for molecular beam epitaxy regrowth is examined. Reflection high-energy electron diffraction, transmission electron microscopy, and capacitance-voltage profiling techniques are used to investigate the regrown interface. A slight enhancement of the electron concentration is seen at the regrown interface due to the incorporation of residual sulfur atoms as donors. The amount of residual sulfur donors is a strong function of the substrate temperature at which regrowth is initiated.

32754 The growth of high quality CdTe on GaAs by molecular beam epitaxy. Reno, J.L. (Sandia National Laboratories, Albuquerque, New Mexico 87185 (US)); Carr, M.J.; Gourley, P.L. *Journal of Vacuum Science and Technology, A (Vacuum, Surfaces and Films) (USA),* 8(2): 1006-1012 (Mar 1990). DOE Contract AC04-76DP00789.

We have grown CdTe (111) on oriented and misoriented GaAs (100) and have characterized the layers by photoluminescence microscopy (PLM) and transmission electron microscopy (TEM). Photoluminescence microscopy showed a totally different type of defect structure for the oriented substrate than for the misoriented substrates. The CdTe grown on the misoriented substrates exhibited only threading dislocations. The CdTe grown on oriented GaAs showed fewer threading dislocations but exhibited a random structure of loops. The loop structure observed by PLM has been identified by TEM as the boundary between twinned crystallites which extend from the CdTe/GaAs interface to the CdTe surface. When viewed along the growth axis, these boundaries between the columnar twins appear as loops and segments. Surface roughness of the GaAs substrate contributes to the initial growth of twinned material. This leads to competitive growth between the twins and the creation of the observed columnar twins. We present for the first time the growth of CdTe on patterned GaAs substrates. By growing on oriented GaAs(100) substrates that had been patterned prior to growth with 12 μm mesas, it is possible to grow material on the mesa top that is twin free and has a low dislocation density.

32755 Absolute pressure dependence of the second ionization level of EL2 in GaAs. Bliss, D.E. (Center for Advanced Materials, Materials and Chemical Sciences Division, Lawrence Berkeley Laboratory, 1 Cyclotron Road, Berkeley, California 94720 (USA)—Department of Materials Science and Mineral Engineering, University of California at Berk *Applied Physics Letters (USA),* 56(12): 1143-1145 (19 Mar 1990). DOE Contract AC03-76SF00098.

We report the results of deep level transient spectroscopy experiments with the second ionization level of the double donor defect (EL2) under uniaxial stress in *p*-type GaAs. We measure the shift in the hole emission rate as a function of stress applied in the [100] and [110] directions. By modeling the valence band with two independently displacing bands and appropriately derived effective masses, we determine the absolute hydrostatic pressure derivative of the defect to be 39±15 meV GPa^{-1}. The shear contribution is negligible. These results are very different from those obtained for the first ionization level, which has a much higher absolute pressure derivative of 90 meV GPa^{-1}.

32756 Surface space-charge dynamics and surface recombination on silicon (111) surfaces measured with combined laser and synchrotron radiation. Long, J.P. (Naval Research Laboratory, Washington, D.C. 20375 (USA)); Sadeghi, H.R.; Rife, J.C.; Kabler, M.N. *Physical Review Letters (USA),* 64(10): 1158-1161 (5 Mar 1990). DOE Contract AC02-76CH00016.

The results of a new experiment, which records transient, pulsed-laser-induced surface photovoltages by following photoemission shifts measured with synchrotron radiation, are reported. Comparison of the surface photovoltage decays with numerical simulations reveals large surface recombination rates for a variety of Si(111) surface preparations. The space-charge layer near the surface is found to govern the surface and bulk carrier concentrations to a remarkable extent, particularly when band bending is large.

32757 Interfacial chemistry of metals on CdTe and ZnTe (110). Wahi, A.K. (Stanford Electronics Laboratories, Stanford University, Stanford, California 94305 (US)); Carey, G.P.; Miyano, K.; Chiang, T.T.; Lindau, I.; Spicer, W.E. *Journal of Vacuum Science and Technology, A (Vacuum, Surfaces and Films) (USA),* 8(2): 1152-1158 (Mar 1990). DOE Contract AC03-82ER13000.

We consider interfacial chemistry and band bending behavior for Al, In, Ag, and Pt overlayers on vacuum-cleaved *p*-CdTe and *p*-ZnTe (110) in a comparative study using ultraviolet photoelectron spectroscopy and x-ray photoelectron spectroscopy. A range of metal–substrate reactivities have been considered: Al reacts strongly with Te, Ag moderately, and In minimally, with no evidence seen for In reaction on ZnTe. Pt exhibits strong alloying behavior with both Cd and Zn. These results for the binaries are compared to metal/HgCdTe interface formation. We find that Hg loss can significantly influence the extent of reaction and/or intermixing for these overlayers, with resulting disruption either inhibiting or facilitating chemical interaction. Reaction and intermixing for Al, Ag, and Pt overlayers on CdTe and ZnTe indicate these interfaces are not ideal. The possible role of defects at these four metal/CdTe and metal/ZnTe interfaces is considered, and provides a consistent explanation for the final Fermi level positions observed.

32758 Molecular beam epitaxy of $AlAs_{0.16}Sb_{0.84}$ and $Al_{0.8}Ga_{0.2}As_{0.14}Sb_{0.86}$ on InAs substrates. Lott, J.A. (Sandia National Laboratories, P. O. Box 5800, Albuquerque, New Mexico 87185-5800 (USA)); Dawson, L.R.; Jones, E.D.; Klem, J.F. *Applied Physics Letters (USA),* 56(13): 1242-1244 (26 Mar 1990). DOE Contract AC04-76DP00789.

Epitaxial films of $AlAs_{0.16}Sb_{0.84}$ and $Al_{0.8}Ga_{0.2}As_{0.14}Sb_{0.86}$ were grown lattice matched on (100) InAs substrates by molecular beam epitaxy. The material was characterized by x-ray diffraction, 4 K photoluminescence, and capacitance-voltage measurement techniques. At 300 K, background acceptor concentrations of 1.8×10^{15} and 1.4×10^{16} cm^{-3} were determined for the unintentionally doped AlAsSb and AlGaAsSb epitaxial layers, respectively. Compensating the AlAsSb and AlGaAsSb epitaxial layers with sulfur doping resulted in high-resistivity material with an effective donor concentration of about 10^{14} and 10^{15} cm^{-3}, respectively.

32759 Phonons in solid argon monolayers. Hakim, T.M. (Department of Physics, Jacksonville University, Jacksonville, Florida 32211 (US)); Glyde, H.R. *Physical Review, B: Condensed Matter (USA),* 41(3): 1640-1644 (15 Jan 1990). DOE Contract FG02-84ER45082.

Inelastic neutron scattering studies of excitations in ^{36}Ar solid monolayers show a large thermal broadening of the scattered intensity between T=4 and 45 K. We find this thermal broadening can be readily explained in terms of anharmonic interactions between the phonons in the monolayers. The phonon energies and lifetimes, calculated using the self-consistent phonon theory, are also very sensitive to the nearest-neighbor spacing a_{NN} as well as

temperature. For $a_{NN} \gtrsim 3.96$ A, the floating monolayer is predicted to be mechanically unstable to vibration.

32760 Moving species during ion mixing in Ge_xSi_{1-x}/metal systems. Xia, W. (Department of Electrical—Computer Engineering, University of California, San Diego, La Jolla, California 92093-0407 (US)); Hewett, C.A.; Fernandes, M.; Lau, S.S.; Poker, D.B. *Journal of Applied Physics (USA)*, 67(4): 1814-1819 (15 Feb 1990). DOE Contract FG03-84ER45156.

The origin of the motion of semiconductors during ion mixing was investigated by studying both the temperature and the atomic mass dependence of moving species in the Ge_xSi_{1-x}/Ni and the Ge_xSi_{1-x}/Pd systems. Ion mixing was performed with 280-keV Ar ions at temperatures between 30 K and room temperature. The atomic mass of the Ge_xSi_{1-x} alloy was adjusted by changing the concentration of Ge in the alloy. In thermally induced reactions, no preferential motion of Si or Ge was observed. During ion mixing, the atomic flux of Si was observed to be enhanced compared to that of Ge. The atomic flux of the sum of Si and Ge to metal decreases with increasing substrate temperature during mixing and with increasing Ge concentration in the Ge_xSi_{1-x} alloy. From the strong atomic mass dependence of the moving species during ion mixing it is concluded that the origin of the motion of semiconductors under ion mixing conditions is due to the effects of secondary recoils.

32761 Effect of transition-metal substitutions on competing electronic transitions in the heavy-electron compound URu_2Si_2. Dalichaouch, Y. (Department of Physics and Institute for Pure and Applied Physical Sciences, University of California, San Diego, La Jolla, California 92093 (US)); Maple, M.B.; Chen, J.W.; Kohara, T.; Rossel, C. *Physical Review, B: Condensed Matter (USA)*, 41(4): 1829-1836 (1 Feb 1990). DOE Contract FG03-86ER45230.

The moderately heavy-electron compound URu_2Si_2 is known to exhibit two electronic phase transitions at low temperatures, one to an antiferromagnetically ordered state at T_N=17.5 K followed by another to a superconducting state at T_c~1.5 K. The shape of the specific-heat anomaly at T_N, which is reminiscent of a second-order BCS-type mean-field transition, suggests the formation of a spin- or charge-density wave opening a gap over part of the Fermi surface. The effect of chemical substitution of the transition metals M=Re, Tc, Os, Rh, and Ir for Ru in URu_2Si_2 has been investigated by means of electrical resistivity, magnetic susceptibility, and specific-heat measurements in $URu_{2-x}M_xSi_2$ for $x \leq 0.2$. The anomaly associated with the 17.5 K transition involves a very small magnetic entropy and is smeared out by very small concentrations of the M substituent. An inverse correlation between T_c and T_N in the Rh- and Ir-doped materials for $x<0.01$ and in the Os-doped series for $x<0.1$ is consistent with the picture of two electronic transitions competing for states at the Fermi level.

32762 Moessbauer spectroscopy study of the kinetics of photoreduction of Fe^{3+} on CdS semiconductor powders. Gessert, T.A. (Solar Energy Research Institute, Golden, CO (USA)); Nozik, A.J.; Williamson, D.L. *Journal of Physical Chemistry (USA)*, 94(5): 1958-1962 (8 Mar 1990).

Photoreduction of Fe^{3+} to Fe^{2+} via illumination of CdS particles suspended in ferric chloride electrolyte has been monitored by ^{57}Fe Moessbauer spectroscopy. The conversion rate was studied as a function of the relative amounts of CdS and Fe^{3+} in the semiconductor powder-electrolyte slurry.

32763 Electrochemical characterization of bilayer lipid membrane-semiconductor junctions. Zhao, Xiao Kang (Syracuse Univ., NY (USA)); Baral, S.; Fendler, J.H. *Journal of Physical Chemistry (USA)*, 94(5): 2043-2052 (8 Mar 1990).

Three different systems of glyceryl monooleate (GMO), bilayer lipid membrane (BLM) supported semiconductor particles have been prepared and characterized. A single composition of particulate semiconductor deposited only on one side of the BLM constituted system A, two different compositions of particulate semiconductors sequentially deposited on the same side of the BLM represented system B, and two different compositions of particulate semiconductors deposited on the opposite sides of the BLM made up system C.

32764 Low-frequency relaxation modes and structural disorder in $KTa_{1-x}Nb_xO_3$. Sokoloff, J.P. (Optical Sciences Center, University of Arizona, Tucson, Arizona 85721 (US)); Chase, L.L.; Boatner, L.A. *Physical Review, B: Condensed Matter (USA)*, 41(4): 2398-2408 (1 Feb 1990). DOE Contract AC05-84OR21400.

A light-scattering study of the low-frequency excitations in single crystals of cubic and tetragonal $KTa_{1-x}Nb_xO_3$ (x=0.26 and 0.28) has been carried out by employing a technique which uses an iodine filter to remove elastically scattered light. Low-frequency Raman and Fabry-Perot components related to structural disorder in the mixed-crystal tantalate-niobate system were observed. The spectral shape, symmetry properties, and thermal behavior of these components are consistent with an eight-site order-disorder model of the sequence of structural phase transitions observed in ferrodistortive perovskites.

32765 Indices governing optical self-focusing and self-induced changes in the state of polarization in N_2, O_2, H_2, and Ar gases. Hellwarth, R.W. (Departments of Electrical Engineering— Physics, University of Southern California, Los Angeles, California 90089-0484 (USA)); Pennington, D.M.; Henesian, M.A. *Physical Review, A (General Physics) (USA)*, 41(5): 2766-2777 (1 Mar 1990). DOE Contract W-7405-ENG-48.

We employ recently published data on the dc Kerr effect and electric-field-induced second-harmonic generation in N_2, O_2, H_2, and Ar gases to calculate the nonlinear-optical indices governing self-focusing, self-induced changes in the state of polarization, and third-harmonic generation, over a wide range of wavelengths in these gases. We construct a new, one-parameter, dispersion formula that not only fits all existing data on the above gases, but also fits recent quantum calculations of each tensor component of the third-order optical susceptibility of helium, over a wide range of frequency arguments. We compare the difference between the predictions of this formula and the predictions of a previously used formula based only on linear refractive-index dispersion. The difference is negligible at 1053 nm but becomes significant at blue or shorter wavelengths (<350 nm), where it indicates the uncertainty in our dispersion calculations. We find the coefficient for self-induced polarization changes in one atmosphere of air to be $c_{1221}(-\omega,\omega,\omega,-\omega) = (24 \pm 2) \times 10^{-19}$ esu, at 1053 nm and 20 °C. This is consistent with one of two reported measurements of this coefficient.

32766 NMR studies of $NbSe_3$: Electronic structures, static charge-density-wave measurements, and observations of the moving charge-density wave. Ross, J.H. Jr. (Department of Physics and Materials Research Laboratory, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801 (US)); Wang, Z.; Slichter, C.P. *Physical Review, B: Condensed Matter (USA)*, 41(5): 2722-2734 (15 Feb 1990). DOE Contract AC02-76ER01198.

We describe a series of ^{93}Nb NMR studies of the charge-density-wave (CDW) conductor $NbSe_3$. Using an aligned, multicrystalline sample, we have measured the complete shift tensors for the three Nb sites in the normal state. The results confirm a picture in which one chain is essentially insulating, and the other two are conducting. Studies below the 144-K CDW transition give well-resolved CDW-broadened line shapes, which indicate that the CDW is incommensurate with little or no lock-in to the lattice. Further NMR measurements performed with the CDW driven by electrical currents give information about the moving CDW. Motional narrowing of the NMR line indicates that the CDW conduction phenomena are associated with bulk motion of the $NbSe_3$ CDW. On the other hand, the motion is irregular at all voltages, as indicated by the large voltage required for motional narrowing, the short T_2, and the behavior of the magnetization under current-induced saturation. Furthermore, NMR spin-echo measurements of the low-voltage dielectric response indicate a spatially nonuniform response of the CDW under its pinning barriers.

32767 Correlated two-photon interference in a dual-beam Michelson interferometer. Kwiat, P.G. (Department of Physics, University of California, Berkeley, California 94720 (USA)); Vareka, W.A.; Hong, C.K.; Nathel, H.; Chiao, R.Y. *Physical Review, A (General Physics) (USA)*, 41(5): 2910-2913 (1 Mar 1990). DOE Contract W-7405-ENG-48.

We report on an interference effect arising from a two-photon entangled state produced in a potassium dihydrogen phosphate (KDP) crystal pumped by an ultraviolet argon-ion laser. Two conjugate beams of signal and idler photons were injected in a parallel configuration into a single Michelson interferometer, and detected separately by two photomultipliers, while the difference in its arm lengths was slowly scanned. The coincidence rate exhibited fringes with a visibility of nearly 50%, and a period given by half the ultraviolet (not the signal or idler) wavelength, while the singles rate exhibited no fringes.

32768 X-ray structure of Cs-doped polyacetylene. Ma, J. (Laboratory for Research on the Structure of Matter, University of Pennsylvania, Philadelphia, Pennsylvania 19104 (US)); Djurado, D.; Fischer, J.E.; Coustel, N.; Bernier, P. *Physical Review, B: Condensed Matter (USA),* 41(5): 2971-2975 (15 Feb 1990). DOE Contract FG02-86ER45254.

The x-ray powder profile of heavily doped $[(CH)Cs_y]_x$ is analyzed on the basis of three dimensionally ordered intercalate channels. Fifteen peaks representing 27 unique reflections are well described (positions and intensities) by a tetragonal pseudocell with $\hat{a}=\hat{b}=9.093$ A, $\hat{c}=7.950$ A containing 24 (CH) and 4 Cs units ($y=0.167$). The Cs and (CH) sublattices are actually incommensurate along $\hat{c}$, with 6.46 undistorted (CH) units per Cs implying $y=0.15$. Reflections with nonzero L are significantly less intense than calculated neglecting the Debye-Waller factor, indicating large-amplitude c-axis thermal motion of Cs ions. The fractional linear in-plane dilation upon replacing K with Cs is within 20% of the corresponding value in graphite intercalates.

32769 Valence photoelectron spectroscopy of Gd silicides. Braicovich, L. (Istituto di Fisica, Politecnico di Milano, P.za Leonardo da Vinci 32, 20133 Milano, Italy (IT)); Puppin, E.; Lindau, I.; Iandelli, A.; Olcese, G.L.; Palenzona, A. *Physical Review, B: Condensed Matter (USA),* 41(5): 3123-3127 (15 Feb 1990).

Gd_3Si_5, GdSi, and Gd_5Si_3 were investigated with photoemission spectroscopy in the photon-energy range 40.8–149 eV by exploiting the energy dependence of the photoemission cross sections and the valence resonance at the crossing of the Gd 4*d*-4*f* threshold. The modification of the spectra versus photon energy, along with their stoichiometry dependence, show the relevance of covalent mixed Gd 5*d*–Si 3*sp* states in the formation of the chemical bond. In the region close to the Fermi level an increase of the *d* contribution is observed. These points are discussed in connection with the existing models of the silicide bond.

32770 Formation of hydrogenated amorphous carbon films of controlled hardness from a methane plasma. Vandentop, G.J. (Center for Advanced Materials, Materials and Chemical Sciences Division, Lawrence Berkeley Laboratory, Berkeley, California 94720 (US)— Department of Chemistry, University of California at Berkeley, Berkeley, California 94720); Kawasaki, M *Physical Review, B: Condensed Matter (USA),* 41(5): 3200-3210 (15 Feb 1990). DOE Contract AC03-76SF00098.

Studies of amorphous hydrogenated carbon (*a*-C:H) film deposition revealed that methyl radicals are the precursor species responsible for the bulk mass deposition of the films, while the ions act to improve the mechanical properties. The films were deposited on Si(100) substrates both on the powered (negatively self-biased) and on the grounded electrodes from a methane rf plasma (13.56 MHz) at 68 to 70 mTorr and 300 to 370 K. The films produced on the powered electrode exhibited superior mechanical properties, such as high hardness. A mass spectrometer was used to identify neutral species and positive ions incident on the electrodes from the plasma, and also to measure ion energies. Methyl radicals were incident on the electrode surface with an estimated flux of 10^{16} cm^{-2} s^{-1}, for a rf power of 50 W. Methyl radicals appear to be the dominant intermediates in the growth of the soft carbon polymer, and there is a remarkable decrease in deposition rate due to the introduction of NO, a radical scavenger. A novel pulsed biasing technique was used so that the role of ions in the plasma could be studied separately. It was found that the hardness of the films depends on the power supplied by the ions to the growing film surface (the time averaged difference between the plasma potential and the electrode potential), but not on the energy of individual ions. The pulsed biasing technique offers an efficient method to adjust the film hardness by independent control of the neutral radical and ion fluxes to the surface.

32771 Hydrogen dissolution in and release from nonmetals. II. Crystalline silicon. Abrefah, J. (Materials and Chemical Sciences Division, Lawrence Berkeley Laboratory, Berkeley, CA (USA)—Department of Nuclear Engineering, University of California, Berkeley, California 94720 (USA)); Olander, D.R.; Balooch, M. *Journal of Applied Physics (USA),* 67(7): 3302-3310 (1 Apr 1990). DOE Contract AC03-76SF00098.

The solubility of hydrogen in crystalline silicon from 1363–1473 K and from 1.7–9.2 atm has been measured using the method of high-temperature, high-pressure infusion followed by high-temperature vacuum outgassing with mass-spectrometric detection. The measured solubilities were in the range $1–5\times10^{16}$ atoms/cm^3 and exhibited a temperature dependence consistent with a heat of solution of 30–40 kcal/mole. The pressure dependence of the solubility was consistently smaller than the square-root dependence characteristic of simple interstitial solution. The release-rate curves showed multiple peaks, which are incompatible with the classical diffusion model of release. Instead the peaks correspond to trapping of hydrogen at distinct binding sites in the silicon lattice. The release kinetics were modeled as detrapping processes.

32772 Lattice-mismatched $In_{0.53}Ga_{0.47}As/In_{0.52}Al_{0.48}As$ modulation-doped field-effect transistors on GaAs: Molecular-beam epitaxial growth and device performance. Chang, K. (Center of High-Frequency Microelectronics— Department of Electrical Engineering and Computer Science, The University of Michigan, Ann Arbor, Michigan 48109-2122 (USA)); Bhattacharya, P.; Lai, R. *Journal of Applied Physics (USA),* 67(7): 3323-3327 (1 Apr 1990). DOE Contract FG02-86ER45250.

We describe here the properties of $In_{0.53}Ga_{0.47}As/In_{0.52}Al_{0.48}As$ modulation-doped heterostructures and field-effect transistors grown directly by molecular-beam epitaxy on GaAs substrates. The generation and nature of dislocations in the films have been studied by transmission-electron microscopy. The final heterostructure contains a series of compositional steps of $In_xGa_{1-x}As$ ($0\leq x\leq0.53$) to generate and control the dislocation movement. The modulation-doped heterostructures are characterized by $\mu_{300K}=8$ 150 cm^2/V s ($n_s=2.7\times10^{12}$ cm^{-2}) and $\mu_{20K}=26$ 100 cm^2/V s ($n_s=2.1\times10^{12}$ cm^{-2}) which compare very favorably with values measured in similar lattice-matched heterostructures on InP. 1.4-μm gate-modulation-doped field-effect transistors exhibit g_m(ext)=240 mS/mm and f_T=21 GHz. The drain current variation with gate bias is linear and the transconductance is uniform over a sizeable voltage range. These material and device characteristics indicate that $In_xGa_{1-x}As/In_xAl_{1-x}As$ transistors (with x varying over a certain range to vary ΔE_c) can be designed on GaAs or even other mismatched substrates.

32773 Molecular-dynamics simulation of amorphous and epitaxial Si film growth on Si(111). Kwon, I. (Ames Laboratory-U.S. Department of Energy, Iowa State University, Ames, Iowa 50011 (USA)); Biswas, R.; Grest, G.S. *Physical Review, B: Condensed Matter (USA),* 41(6): 3678-3687 (15 Feb 1990). DOE Contract W-7405-ENG-82.

Both amorphous and epitaxial crystalline Si films have been grown by deposition of Si-atom clusters on a Si(111) substrate with molecular-dynamics simulations utilizing two- and three-body interatomic Si potentials. The amorphous films were produced with deposition conditions that led to low surface diffusion. The *a*-Si films displayed voids, a 15–28 % lower density than *c*-Si, and coordination defects consisting only of undercoordinated atoms with no fivefold-coordinated atoms, in contrast to melt-quenched *a*-Si models. The epitaxial Si(111) growth was achieved under conditions of high surface diffusion consisting of a large initial cluster velocity and moderate substrate temperatures.

32774 Temperature dependence of compositional disordering of GaAs-AlAs superlattices during MeV Kr irradiation. Bryan, R.P. (Materials Research Laboratory, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801 (USA)); Miller, L.M.;

Cockerill, T.M.; Coleman, J.J.; Klatt, J.L. *Physical Review, B: Condensed Matter (USA)*, 41(6): 3889-3892 (15 Feb 1990). DOE Contract AC02-76ER01198.

The influence of the specimen temperature during MeV Kr irradiation on the extent of compositional disordering in GaAs-AlAs superlattices has been determined. For low-temperature irradiations (133–233 K), complete intermixing of the superlattice is observed. However, the mixing efficiency *decreases* with increasing specimen temperature between room temperature and 523 K. These results suggest the existence of a miscibility gap in the coherent-phase diagram of GaAs-AlAs superlattices with a critical temperature greater than 523 K.

32775 Fourier-transform and continuous-wave EPR studies of nickel in synthetic diamond: Site and spin multiplicity. Isoya, J. (University of Library and Information Science, Kasuga 1-2, Tsukuba-city, Ibaraki-ken 305, Japan (JP)); Kanda, H.; Norris, J.R.; Tang, J.; Bowman, M.K. *Physical Review, B: Condensed Matter (USA)*, 41(7): 3905-3913 (1 Mar 1990). DOE Contract W-31109-ENG-38.

Pulsed, Fourier-transform, and continuous-wave electron paramagnetic resonance methods are used to study the g=2.0319 EPR signal in synthetic diamond crystals. This signal is from Ni which is found to be located at a substitutional site in the diamond lattice without detectable nearby charge compensation. The effective spin state of S=3/2 is determined from Fourier-transform nutational EPR spectroscopy. It is proposed that the center is a Ni^- ion with electronic configuration $3d^9$.

32776 Melting and orientational epitaxy in argon and xenon monolayers on graphite. D'Amico, K.L. (Department of Physics, Brookhaven National Laboratory, Upton, New York, 11973-5000 (USA)— Corporate Research Laboratories, Exxon Research and Engineering Company, Clinton Township, Route 22 East, Annandale, New Jersey 08801 (USA)); Bohr, J. *Physical Review, B: Condensed Matter (USA)*, 41(7): 4368-4376 (1 Mar 1990). DOE Contract AC02-76CH00016.

We have studied the melting behavior for Ar at a coverage of $\rho \sim 0.81$ and the orientational-epitaxy effect for Ar and Xe. We find that the Ar melts continuously from a rotated incommensurate solid to a rotated fluid phase; the fluid with positional correlations of 400 *A* is rotated by ~2°. The melting behavior agrees well with that observed by x-ray diffraction using a *ZYX*-graphite substrate, and is consistent with the heat-capacity data of Migone *et al.* For Xe, the orientational-epitaxy data show a rotation to zero for increasing misfit magnitude, contrary to the Ar and Kr behavior. This is discussed in light of the role of entropy in the structure of this system.

32777 Determination of lattice structure and calculation of molecular tilt in lipid monolayers on water using x-ray diffraction. Bohanon, T.M. (Department of Physics— Department of Astronomy, Northwestern University, Evanston, Illinois 60208 (USA)); Lin, B.; Shih, M.C.; Ice, G.E.; Dutta, P. *Physical Review, B: Condensed Matter (USA)*, 41(7): 4846-4849 (1 Mar 1990). DOE Contract FG02-84ER45125.

We report the first determination of lattice structure for classical (fatty acid and alcohol) monolayer systems on the surface of water, based on our observation of first- and second-order x-ray diffraction peaks. Monolayers of both heneicosanoic acid and heneicosanol in the highest-pressure phase pack into a distorted hexagonal lattice with orthorhombic cell dimensions of $a \cong 7.5$ *A*, $b \cong 5.0$ *A*. From the observed peak intensities, we have calculated the molecular tilt directions and magnitudes, using the assumption (reasonable given the dense packing) that the chains are parallel to each other and in the all-*trans* configuration. the temperature range 0–5 °C, the molecules tilt towards the *b* axis, but at higher temperatures the tilt direction changes to the *a* axis.

40 CHEMISTRY

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4001 Analytical and Separations Chemistry

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32778 (CEA-N–2616) **Faster radiotoxicological analyses of alpha emitters.** Willemot, J.M.; Verry, M. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection Sanitaire. Oct 1989. 8p. (In French). Order Number DE90792921. Available from NTIS (US Sales Only), PC A02/MF A01.

Ion-exchange resins allow efficient separation of actinides likely to be found in human biological samples. However, time saving during the analysis is most interesting for the biologist especially if the separation and spectrum qualities are not affected. Such a result is possible with urine or feces using a macroporous resin.

32779 (CNIC–00237) **Mass spectrometric measuring of nuclear fuel burnup.** Deng Zhongguo (Academia Sinica, Beijing, BJ (China). Inst. of Atomic Energy); Zhao Motian; Gao Shuqin; Li Silin. China Nuclear Information Centre, Beijing, BJ (China). 1988. 10p. (In Chinese). (IAE–0049). Order Number DE90627756. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A mass spectrometric determination of burnup in the nuclear fuel is presented. The accuracies of results obtained by amounts of ^{236}U growth, ^{235}U decrease and indictor ^{148}Nd are 1.6-4.0%. The burnup values determined by mass spectrometric, γ-radioactive and radiochemical methods are coincident with each other. The axial distributions of the uranium isotopic ratios, α_5 and burnup are given. The correlation curves of the uranium isotopic ratios versus the burnup values are straight lines. The correlation curve of the ^{149}Sm-concentration of a poison fissile product versus the burnup values is also a straight line.

32780 (CONF-900402–7) **Sulfur species in perchloroethylene and other coal extracts.** Vorres, K.S. Argonne National Lab., IL (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 199. national meeting of the American Chemical Society; Boston, MA (USA); 22-27 Apr 1990. Order Number DE90011163. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Earlier work has indicated that elemental sulfur can be removed from coal by the use of perchloroethylene (tetrachloroethylene). The unique ability to remove the elemental form of the sulfur has led to considerable interest in the process and mechanism of action. An effort has been made to understand the species that can be removed by extraction with perchloroethylene (PCE). The effort involved the extraction of a set of coals, and the related effort to identify the species in the extract by the use of gas chromatography-mass spectrometry at the Argonne National Laboratory (ANL). This paper reports on the analytical work on the extracts. 4 refs.

32781 (CONF-900704–10) **Rate constants for the reaction, $O + H_2O \rightarrow OH + OH$, over the temperature range, 1500–2400 K, by the flash photolysis-shock tube technique: A further consideration of the back reaction.** Lifshitz, A.; Michael, J.V. Argonne National Lab., IL (USA). [1990]. 28p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 23. Combustion Institute symposium on combustion; Orleans (France); 22-27 Jul 1990. Order Number DE90010500. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Rate constants for the reaction, $O + H_2O \rightarrow OH + OH$, have been measured by the Flash Photolysis-Shock Tube (FP-ST) technique over the temperature range, 1500–2400 K. This technique combines stock heating with flash photolysis in the reflected shock wave regime, and the transient species, O-atoms in this case, are monitored by atomic resonance absorption spectroscopy (aras). Additional experiments were performed with N_2O as a thermal source of O-atoms, and the formation and depletion of [O] were followed by the aras technique. These results require that the decomposition rate behavior of N_2O be known. The results obtained by this technique are compared to those obtained by the FP-ST technique and are found to be corroborative. Hence, the combined results are

used to describe the rate constants for the title reaction. The experimental results are compared to earlier work, and rate constants for the title reaction are additionally calculated from published results for the reverse reaction, OH + OH, and the well known equilibrium constant. All results are combined, and the rate behavior for the title reaction is evaluated. Lastly, the results for both forward and reverse reactions are compared to the theoretical calculations presented recently by Harding and Wagner. It is concluded that theory and expériment are in agreement within experimental error.

32782 (CONF-900724–7) **Rapid determination of nicotine in urine by direct thermal desorption ion trap mass spectrometry.** Wise, M.B.; Ilgner, R.H.; Guerin, M.R. Oak Ridge National Lab., TN (USA). [1990]. 7p. Sponsored by U.S. Department of Health and Human Services. DOE Contract AC05-84OR21400. From 5. international conference on indoor air quality and climate; Toronto (Canada); 29 Jul - 3 aug 1990. Order Number DE90009423. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The measurement of nicotine and cotinine in physiological fluids (urine, blood serum, and saliva) is widely used as a means of assessing human exposure to environmental tobacco smoke (ETS). Although numerous analytical methods exist for these measurements, they generally involve extensive sample preparation which increases cost and decreases sample throughput. We report the use of thermal desorption directly into an ion trap mass spectrometer (ITMS) for the rapid determination of nicotine and cotinine in urine. A 1 μL aliquot of urine is injected into a specially designed inlet and flash vaporized directly into an ITMS through an open-split capillary restrictor interface. Isobutane chemical ionization is used to generate $(M+H)^+$ ions of the analytes and collision induced dissociation is used to generate characteristic fragment ions which are used to confirm their identity. Quantification is achieved by integrating the ion current for the characteristic ions and comparing with an external working curve. Detection limits are approximately 50 pg per analyte and the sample turnaround time is approximately 3 minutes without the need for extensive sample preparation. 12 refs., 5 figs.

32783 (DOE/ER/13435–4) **Fundamental studies with a monodisperse aerosol-based liquid chromatography/mass spectrometry interface (MAGIC-LC/MS): Progress report, September 1, 1985–November 30, 1989.** Browner, R.F. Georgia Inst. of Tech., Atlanta, GA (USA). School of Chemistry. May 1989. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-85ER13435. Order Number DE90010667. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A number of accomplishments have been made during the term of this grant. These include both technical aspects of the project, and developments associated with commercial development of the MAGIC- LC/MS interface. Technical advances have been made through a number of detailed studies of fundamental processes occurring with the interface. These have led to substantial improvements in the performance of the interface many of which are detailed below. Of particular importance has been a major improvement in detection capabilities. At beginning of this grant period, sensitivity for many compounds was in the high μg to low mg range. Presently, full-scan (40-400 daltons) electron impacts mass spectra may be obtained for many compounds with typically 10–50 ng of material injected on column. Selected ion monitoring gives detection limits in the range of 100–1000 pg. These figures are particularly noteworthy because they represent values which fall between 3–10x the lowest detection limits possible with the same instrument when used in a GC/MS mode.

32784 (DOE/ER/13542–4) **Studies of the analyte-carrier interface in flow injection analysis: Project report, June 1, 1987–December 1, 1989.** Brown, S.D. Delaware Univ., Newark, DE (USA). Dept. of Chemistry. [1990]. 27p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13542. Order Number DE90010811. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The chemical analysis of species in flowing solution has become popular because it provides a low-cost, rapid way to automate many classical methods. Most of the classical methods used to detect the products of the reaction between analytes and reagents in the carrier are not specific enough to permit direct multicomponent analysis of even relatively simple mixtures, however. Two possible routes to enhancing the specificity of the detector are available: (1) enhance the specificity of detection through a competitive reaction of analytes with a species in the carrier, thereby using the dispersion and diffusion properties of flowing systems to effect a distribution of detectable species across the injected bolus, or (2) use a rapidly scanned detector in concert with mathematical methods for enhancing spectral selectivity. The first method is a competitive kinetic analysis carried out in a flowing medium, with a dispersion-controlled mixing of reactants. The second is a direct multicomponent analysis, applied to a transient sample. The two approaches share some common features, since kinetic and dispersion effects complicate the multicomponent analysis, and because rapid spectral measurement is necessary to map the distribution of reactants and products which is required to evaluate the kinetics of a dispersion-controlled, competitive chemical reaction. The project has as goals the study of rapid multicomponent analysis of transient species in flowing media, the investigation of chemical reactions at interfaces, and the investigation of the effects of competition on the distribution products from an interfacial reaction. Work required to meet these goals includes development of new methods for rapid multicomponent analysis, and the examination of newer methods of detection for interfacial and transient species.

32785 (EGG-M–89267) **Long-term stability of solid standards for radiochemical analysis.** Sill, C.W. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 4p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-8910241–6: 35. conference on bioassay, analytical and environmental chemistry, Charleston, SC (USA), 30 Oct - 2 nov 1989). Order Number DE90010948. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

In a previous publication, the present author presented a procedure for the preparation of standard soils containing known concentrations of any artificial nonvolatile radionuclide by spiking natural −200 mesh soil with a standard solution of the desired radionuclide. Several authors have questioned the long-term stability of such standards because of possible segregation of the different sizes of particles. Several of the spiked standards prepared previously were still available whose previous storage history was known with confidence because of some unique circumstance. In addition, several −200 mesh standards of uranium ores and mill tailings that had been analyzed carefully and repeatedly for ^{230}Th were also available. It is the purpose of the present paper to present the results of careful reanalysis of these aged standards in profile and the evidence as to the length of time since they could have been mixed or disturbed in any way. It was particularly important that the measurements be as precise and reliable as possible so that the conclusions would not be obscured by imprecise data. 2 refs.

32786 (FRNC-R–274) **Electron-probe microanalysis: x-ray spectroscopy.** Association Nationale de la Recherche Technique (ANRT), 75 - Paris (France). 1987. 141p. (In French). Order Number DE90792879. Available from NTIS (US Sales Only), PC A07/MF A01.

The main principles on X-ray, energy and wave length dispersive spectroscopy are reviewed. In order to allow the choice of the best operating conditions, the importance of the regulation and control systems is underlined. Emission theory, X-rays nature and its interaction with matter and electrons in the matter is shown. The structure, operating procedures and necessary electronics (single channel - analysis chain) automatic-control system for the threshold-energies discrimination and the energy distribution visualization associated to the wavelength dispersive spectroscopy are described. The focusing control, resolution, influence of chemical bonds and multilayer-structure monochromators related to wavelength dispersive spectroscopy are studied. Concerning the energy-dispersive spectroscopy, the detector, preamplifier, amplifier, analog-digital converter, as well as the utilization and control of the spectrometer are described. Problems and instrumental progress on energy-dispersive spectroscopy related to the electronic-noise control, charge collection and light-elements detection are discussed.

32787 (IPNO-DRE–89-40) **Separation of californium from actinides and lanthanides in aqueous solution by electrochemical formation of amalgams.** David, F. (Paris-11 Univ., 91 - Orsay (FR). Inst. de Physique Nucleaire); Fourest, B.; Peretrukin, V.F.; Maslennikov, A.G. Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire. 1989. 11p. Order Number DE90792927. Available from NTIS (US Sales Only), PC A03/MF A01.

The electrochemical reduction of some transplutonium elements (Pu - Cf) and rare earths (Eu, Tm) from aqueous complexing solutions to amalgams was studied over a wide range of cathodic potentials in order to get the best separation of californium. The reduction process in acetate media (pH 1.5 - 4.6) at potential around - 1.7, 1.9 V leads to quantitative extractions of californium into the mercury phase, while more negative potentials are required for the reduction of the lighter transuranium elements and lanthanides. Thus, the optimal conditions of the californium purification from the investigated actinides and lanthanides were determined. Separation factors α were found to be 25 - 90 excepted in the case of Cf/Eu, where poor values (α varying from 7 to 12) were observed. Applications of more negative cathodic potentials decrease the selectivity of the reduction process. A similar study with lithium citrate solutions (pH $\approx$ 6) shows that a good separation of californium from lighter and heavier actinides is achievable. Separation factor of 88 is obtained for Cf/Am at - 1.98 V. The anodic stripping of mixed amalgams (Pu, Am, Cm, Bk, Tm and Cf) Hg in nitric acid and acetic solutions at potentials + 0.1, - 0.7 V proceeds slowly and proved to be uneffective for californium separation from light actinides under described conditions.

32788 (ORNL/FTR–3604) **[Applied mass spectrometry in the health sciences]: Foreign trip report, April 15–April 21, 1990.** Glish, G.L. Oak Ridge National Lab., TN (USA). 3 May 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90010838. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler attended the 2nd International Symposium on Applied Mass Spectrometry in the Health Sciences and presented and invited paper. Papers presented that were of interest to ORNL mass spectrometry programs involved ionization of large molecules by electrospray and laser desorption. Other papers of interest included applications of MS/MS for structural elucidation and new instrumentation.

32789 (UCRL–102494) **Kinetic modeling of ethene oxidation at low and intermediate temperatures.** Wilk, R.D. (Union Coll., Schenectady, NY (USA). Dept. of Mechanical Engineering); Pitz, W.J.; Westbrook, C.K.; Cernansky, N.P. Lawrence Livermore National Lab., CA (USA); Drexel Univ., Philadelphia, PA (USA). Dept. of Mechanical Engineering and Mechanics. 13 Dec 1989. 18p. Sponsored by U.S. Department of Defense; U.S. DOE Conservation & Renewable Energy. DOE Contract W-7405-ENG-48;FG04-87AL44658. Contract DAAG29-85-K-0253. (CONF-900704–5: 23. Combustion Institute symposium on combustion, Orleans (France), 22-27 Jul 1990). Order Number DE90005998. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A detailed chemical kinetic mechanism for ethene oxidation has been developed and used to model intermediate temperature oxidation chemistry. The model was used to simulate the reactions in a static reactor at temperatures of 696K and 718K, an equivalence ratio of 2.0, and a pressure of 600 torr. Modeling results at these conditions were compared with experimental species concentration data. The calculated concentrations of the major products ethene oxide and carbon monoxide are in very good agreement with the experimental data. The calculated maximum concentrations of formaldehyde and methanol are slightly low, but the shapes of the profiles follow closely the experimental species histories. The calculated methane concentrations are in good agreement in the early stages of the reaction, but are overpredicted in the latter stages. The predicted carbon dioxide levels are low in the early stages of the reaction. The modeling calculations identified some of the key reaction steps at the present conditions. The addition of HO_2 and OH radicals to ethene and their subsequent reactions are responsible for the formation of the majority of the reaction intermediates. 32 refs., 3 figs.

32790 **Spherical pinch discharges for elemental analysis.** Scheeline, A. (Illinois Univ., Urbana, IL (USA). School of Chemical Sciences); Lee, G.H. 1-1 of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 692a.

Spherical pinch discharges have been shown to be more efficient for producing fusion plasmas than linear theta or Z pinches. They are thus worthy of investigation for their utility in elemental analysis of refractory solids, where linear theta pinches can sample materials regardless of boiling point, but are inefficient in transferring energy from the discharge to the analyte. The authors report preliminary characterization of both a theta and Z pinch configuration of spherical pinches for elemental analysis. Experiments include characterization of temporal behavior, sampling of assorted refractory materials, and effect of particle size on observed emission. Conclusions as to the eventual analytical utility of pinch discharges for bulk elemental analysis of solids, based on instrumental reliability, complexity, safety, and cost are drawn.

32791 **Counterfeit currency detection by principal component analysis of near infrared reflectance data.** Dale, J.M. (Oak Ridge National Lab., TN (USA)); Klatt, L.N. 1-1 of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 945.

Recent incidences of product tampering and frequent reports of product counterfeiting are increasing the need for methods to determine product authenticity. One of the concepts that the authors are investigating for the detection of counterfeit documents involves the use of pattern recognition techniques to analyze multivariant data acquired from properties intrinsic to the document. The objective of this work was to provide a proof-of-principle demonstration to determine if the application of pattern recognition techniques to near infrared reflectance data from paper currency could be used to classify the currency as belonging to a genuine or counterfeit class.

32792 **Spatial distribution of atomic and molecular species in inductively coupled plasmas (ICP): By monochromatic imaging and image analysis.** Hareland, W.A. (Sandia National Labs., Albuquerque, NM (USA)); Williamson, R.L. 1-1 of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). DOE Contract AC04-76DP00789. (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 297.

The spatial distribution of analyte species in inductively coupled plasma sources is very critical for quantitative atomic emission analysis. Knowledge of the analyte distribution is useful in selecting the optimum region for measuring atomic emission. A technique for imaging atomic emission sources would be extremely valuable in determining the parameters that influence the analyte distribution in plasmas. This paper describes the design and performance of a high resolution monochromatic video imaging system and the application of monochromatic imaging to the analyses of inductively coupled plasmas. The instrument consists of a grating monochromator with a single lens optical system, an intensified array detector mounted in a video camera, and an image processor. The monochromatic instrument has high spectral, temporal, and spatial resolution. The spectral bandpass is less than 1.0 nm over the range from 210 to 900 nm, and the exposure time can be varied from 100 nsec to 15 nsec by gating the detector. Images are acquired at a standard video rate of 30 frames per second.

32793 **Enhanced fluorescence and Raman analysis of DNA-adduct products.** Johnson, R.W. (Oak Ridge National Lab., TN (USA). Health and Safety Research Div.); Bello, J.; Vo-Dinh, T. 1-1 of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference,

Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-890331--: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 197.

Polynuclear aromatic (PNA) hydrocarbons are generally recognized as potential carcinogens and mutagens. Conversion of these compounds via chemical or metabolic activation leads to highly reactive electrophiles which undergo attack at nucleophilic centers in DNA. While the aromatic nucleus of the PNA molecule allows detection by luminescence, extremely sensitive assays are required due to the low levels of environmental exposure leading to DNA adduct formation. The authors report on the development of sensitive methods to detect a model PNA, benzo(a)pyrene and several of its metabolites by fluorescence and surface-enhanced Raman scattering (SERS). The use of various sensitizing agents to enhance the sensitivity of fluorescence analyses on paper surfaces was investigated. Using a solid substrate covered with a silver-coated microparticle substrate, the SERS spectra of several DNA adducts were obtained. The results showed that the SERS spectra of the DNA adducts could be used as "fingerprints" for each compound. In addition, SERS analytical figures of merit such as linear range, reproducibility of signal, and limits of detection were obtained for some of the DNA adducts.

32794 The infrared microspectroscopic determination of a polymer dopant using partial and classical least-squares chemometric methods. Ward, K.J. (Sandia National Labs., Albuquerque, NM (USA)). 1-1 of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). DOE Contract AC04-76DP00789. (CONF-890331--: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 087.

Full-spectrum classical least-squares and partial least-squares multivariate chemometric algorithms have been applied to FT-IR microscpectroscopic data of a doped polymer system. The concentration of trinitrofluorenone, a radiation hardening agent, was determined as a function of depth in polyethylene terephthalate (mylar) films. The 25-mil thick mylar films were dipped in a solution of TNF in ethylene glycol. These doped films were dried and then cross-sectioned using a microtome to result in a four micrometer film thickness. FT-IR microscopy transmission spectra were then acquired on each 20 micrometer section of the film from the edge to the center of the film using 20 x 200 micrometer redundant aperturing. The relative concentrations determined from the multivariate chemometric methods were normalized, by assuming the bulk TNF uptake, determined by weight gain measurements after the dipping process, is represented in the 200 micrometer cross-section examined. A comparison of the classical and partial least-squares methods is performed by evaluation of the spectral residuals. Results indicate that quantitative analysis using infrared microspectroscopy is indeed feasible when care is taken to ensure the reproducibility of spectral and pathlength conditions throughout the analysis.

32795 Ion injection and ms/ms studies with a 3-dimensional quadrupole. McLuckey, S.A. (Oak Ridge National Lab., TN (USA). Analytical Chemistry Div.); Glish, G.L.; van Berkel, G.J.; Asano, K.G. 1-1 of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-890331--: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 1002.

The authors are currently exploring and expanding the capabilities of a 3-dimensional quadrupole, specifically, the Finnigan ion trap mass spectrometer (ITMS), as an analytical mass spectrometer. As part of this effort, they have recently modified an ITMS for injection of ions from an external ion source. The capability for efficient ion injection into an ITMS will expand its range of applications to those which are not well served by the conventional means of ionization, viz. ionization within the trap. These applications include, for example, those which require desorption ionization or negative ion formation. They are particularly interested in negative ions and have been studying their injection from an atmospheric sampling glow discharge ionization (ASGDI) source. The efficiency with which ions can be injected will ultimately determine whether an ion trap is suitable for some applications. Collision-induced dissociation and presumably, electron detachment from negative ions, is often observed for injected ions. Collision-induced dissociation can be minimized with the proper selection of operating conditions but as yet has not been eliminated for particularly fragile ions. Data are shown to demonstrate these observations for both positive and negative ions. Data are also given for injection of ions formed by atmospheric pressure ionization (API). These results are compared and contrasted with those obtained using the ASGDI source under similar conditions.

32796 In situ surface-enhanced Raman spectroscopy using new TiO2 based substrates. Bello, J.M. (Oak Ridge National Lab., TN (USA). Health and Safety Research Div.); Stokes, D.L.; Vo-Dinh, T. 1-1 of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-890331--: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 349.

Surface-enhanced Raman scattering (SERS) has been observed from several solid-substrates such as metal electrodes, metal island films, and glass or cellulose coated with silver-coated microparticles. However, with the exception of metal electrodes, most of the studies performed to date with other solid substrates have been limited to drystate SERS analysis. The ability to obtain SERS in solution is important because it will allow new applications of SERS such as in situ analysis. This article reports on a study in which a new substrate was investigated for the feasibility of in situ SERS analysis. The substrate that was used in this study consisted of a glass plate covered with silver-coated TiO_2. The TiO_2, which has a nominal particle diameter of 0.2 micron, provided the necessary surface submicron roughness for the SERS process. The effect of substrate conditions such as silver thickness and amount of TiO_2 on SERS intensity were investigated. In addition, other experimental parameters including the solvent, the laser power, and the substrate geometry were found to have significant effect on the SERS intensity of compounds in solution. It was shown further that the solution SERS intensity obtained with this method was stable with time and that the SERS intensity did not appear to be affected significantly by exposure to laser radiation. The analytical figures of merit such as SERS spectral features, signal reproducibility, and limits of detection were obtained to demonstrate the analytical potential of this method.

32797 Solvent extraction equilibria of tervalent lanthanides: A systematic investigation of selectivity of chelate extraction. Freiser, H. (Strategic Metals Recovery Research Facility, Dept. of Chemistry, Univ. of Arizona, Tucson, AZ (US)). 99-114 of Rare earths: Extraction preparation and applications. Bautista, R.G.; Wong, M.M. The Metallurgical Society Inc., Warrendale, PA (USA) (1988). (CONF-890251--: Rare earth conference: extraction preparation and applications meeting, Las Vegas, NV (USA), 27 Feb - 2 mar 1989).

For the last several years, a systematic investigation of the equilibrium extraction behavior or selective tervalent lanthanides with representative chelating extractions of a variety of chelating agent families has been undertaken for the purpose of learning how to obtain chelating extractants of improved selectivity for separating individual lanthanide ions. The equilibrium extraction data (expressed as log K_{ex}) for each reagent system are linearly related to the reciprocal ionic radius of the tervalent lanthanide ions. The role of adduct formation, steric hindrance, as well as the nature of the bonding atom in the chelate ring, represent some of the factors affecting selectivity arising out of our database of over 200 individual extraction systems, which is discussed.

32798 Bubble attachment time measurements for selected rare-earth phosphate minerals in oleate solutions. Cross, W.M.

(Dept. of Metallurgy and Metallurgical Engineering, Univ. of Utah, Salt Lake City, UT (US)); Miller, J.D. 45-55 of Rare earths: Extraction preparation and applications. Bautista, R.G.; Wong, M.M. The Metallurgical Society Inc., Warrendale, PA (USA) (1988). (CONF-890251–: Rare earth conference: extraction preparation and applications meeting, Las Vegas, NV (USA), 27 Feb - 2 mar 1989).

Bubble attachment time measurements for the rare-earth phosphate minerals monazite and xenotime were made as a function of oleate concentration, sodium fluoride addition, and temperature. Results indicate that the rare-earth phosphates behave similarly to other phosphate minerals, notably collophanite and fluorapatite, which have been studied previously. The addition of sodium fluoride yielded a modest decrease in bubble attachment time with fluoride additions below the apparent fluoride surface precipitation point, while at fluoride additions greater than the apparent precipitation point a significant decrease in attachment time occurs. Increasing the temperature of the system gave a slight decrease in bubble attachment time in the absence of sodium fluoride. With sodium fluoride addition and below the apparent fluoride surface precipitation point, an increase in temperature actually increased the attachment time. For sodium fluoride additions above the apparent fluoride surface precipitation point, a temperature increase significantly decreased the attachment time.

32799 **Process variables in the preparation of high purity rare earth metals.** Beaudry, B.J. (Ames Lab., Iowa State Univ., Ames, IA (US)); Palmer, P.E.; Gschneidner, K.A. Jr. 187-191 of Rare earths: Extraction preparation and applications. Bautista, R.G.; Wong, M.M. The Metallurgical Society Inc., Warrendale, PA (USA) (1988). DOE Contract W-7405-ENG-82. (CONF-890251–: Rare earth conference: extraction preparation and applications meeting, Las Vegas, NV (USA), 27 Feb - 2 mar 1989).

The effect of various levels of purity of the rare earth fluorides and the calcium reductant used to prepare rare earth metals were determined. Metals which have low melting points such as La, Ce, Pr and Nd are not purified by distillation or sublimation. Impurities in the reactants remain as contaminants in these metals. Gd, Tb, Y and Lu which have slightly higher vapor pressures at their melting points than the first four metals are usually distilled to remove the Ta or W impurity introduced by the crucible and are purified slightly with respect to O and N by distillation. Rare earth metals that have high vapor pressures such as Sc, Dy, Ho and Er can be purified with respect to O, N, C, as well as Ta or W by sublimation. The most volatile rare earth metals Sm, Eu, Tm and Yb are readily purified by sublimation and are usually prepared by a reduction-distillation process directly from the oxide. The importance of each step of the processes in determining the final purity of the individual rare earth metals is discussed.

32800 **Kinetic and x-ray photoelectron spectroscopic studies of the thermal nitridation of Si (100).** Peden, C.H.F., Rogers, J.W. (Sandia National Lab, Albuquerque, NM (US)); Blair, D.S., Nelson, G.C. 215-221 of Chemical perspectives of microelectronic materials. Gross, M.E.; Jasinski, J.M.; Yates, J.T. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC04-76DP00789. (CONF-8811223–: Chemical perspectives of microelectronic materials, Boston, MA (USA), 30 Nov - 2 dec 1988).

This paper reports thermal nitridation of Si(100) by NH_3 and N_2H_4 studied by X-ray photoelectron (XPS) and Auger electron (AES) spectroscopies. The pressure dependence of the rates as a function of reaction time has been measured. It has been found that the growth of the first monolayer (ML) of nitride is mediated by a surface reaction step. For subsequent growth, diffusion of one or more of the reacting species becomes an important process in determining the rate of reaction. Such species may be substrate Si diffusing to the vacuum/Si_3N_4 interface, or possibly network nitrogen diffusing into the Si substrate. The independence of the reaction rate on NH_3 or N_2H_4 pressure at long reaction times rules out a mechanism involving molecular diffusion of the nitriding gas to the Si_3N_4/Si interface in a manner similar to the oxidation of Si by O_2 or H_2O. Careful analysis of the Si(2p) XPS spectra reveals the presence of a unique Si species with a Si(2p) binding energy intermediate between elemental Si and Si in Si_3N_4. Further, the relative intensity of the Si(2p) features due to this species, and the angular dependence of the XPS peaks indicate that they result from a ML of Si at the outermost surface layer, on top of the growing Si_3N_4 film.film.

32801 **Ultrafast time-resolved fluorescence spectroscopy.** Lin, S.H. (Department of Chemistry— Center for the Study of Early Events in Photosynthesis, Arizona State University, Tempe, Arizona 85287-1604 (US)); Fain, B.; Yeh, C.Y. *Physical Review, A (General Physics) (USA)*, 41(5): 2718-2729 (1 Mar 1990). DOE Contract FG02-88ER13969.

We present a theory of time-resolved emission spectroscopy in the femtosecond region. It is shown that a femtosecond time-resolved emission spectrum consists of the contributions from the population and coherence of the system. Theoretical expressions for describing femtosecond time-resolved emission molecular spectra based on the use of the adiabatic approximation are derived. Detailed numerical calculations have been carried out to show the effect of the time evolution of the population and coherence on the time-resolved emission spectra.

4002 Inorganic, Organic, and Physical Chemistry

Refer also to citation(s) 32050, 32200, 32217, 32274, 32592, 32626, 32723, 32780, 32797, 32799, 32835

32802 (CONF-891119–132) **High T_c oxide solid state reaction kinetics via complex impedance spectroscopy.** Cooper, E.A. (Northwestern Univ., Evanston, IL (USA). Dept. of Materials Science and Engineering); Mason, T.O.; Balachandran, U.; Kullberg, M.L. Argonne National Lab., IL (USA). [1989]. 4p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract W-31109-ENG-38. Grant NSF-DMR-8809854. From Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90011178. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Impedance spectra (5Hz – 13MHz) were collected during the solid state reaction of $YBa_2Cu_3O_{6+y}$ from large monosized CuO particles imbedded in a finely divided $Y_2O_3/BaCO_3$ matrix. No particle size effect was observed, but a large temperature effect was observed corresponding to an activation energy of approximately 1.8 eV (175kJ/mol) over the range 700–900°C. 7 refs., 3 figs.

32803 (CONF-8908191–3) **Importance of weak hydrogen bonding C-H–donor and C-H–anion interactions in governing the structural properties of organic donors BEDT-TTF and BEDO-TTF and their charge-transfer salts.** Whangbo, M.-H. (North Carolina State Univ., Raleigh, NC (USA). Dept. of Chemistry); Jung, D.; Ren, J.; Evain, M.; Novoa, J.J.; Mota, F.; Alvarez, S.; Williams, J.M.; Beno, M.A.; Kini, A.M. Argonne National Lab., IL (USA). [1989]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 1. ISSP international symposium on the physics and chemistry of organic superconductors; Tokyo (Japan); 27-30 Aug 1989. Order Number DE90010502. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

On the basis of ab initio SCF-MO/MP2 and semi-empirical MNDO SCF-MO calculations, we examined the structural characteristics of neutral organic donor molecules BEDT-TTF and BEDO-TTF and their charge-transfer salts. The donor···donor and donor···anion interactions associated with the C-H bonds of the donor molecules are found to play a crucial role in governing the packing patterns of the donor molecules, which, in turn, greatly influence the physical properties of the donor molecule salts. 14 refs.

32804 (DOE/ER/13950–2) **PEPICO [photoelectron photoion coincidence] studies of ion dissociations: The structure and heats of formation of ions, molecules, and free radicals: Progress report, April 1989–March 1990.** Baer, T. North Carolina Univ., Chapel Hill, NC (USA). Dept. of Chemistry. [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER13950. Order Number DE90010790. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This report briefly describes progress during the period of April, 1989 to March, 1990. Work on the supersonic beam photoionization apparatus and tunneling processes in ionic dissociations highlight the report. (JDL)

32805 (IC–89/418) **Thermodynamics and structure of liquid alkali metals from the charged-hard-sphere reference fluid.** Lai, S.K.; Akinlade, O.; Tosi, M.P. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 26p. Order Number DE90627792. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The evaluation of thermodynamic properties of liquid alkali metals is re-examined in the approach based on the Gibbs-Bogoliubov inequality and using the fluid of charged hard spheres in the mean spherical approximation as reference system, with a view to achieving consistency with the liquid structure factor. The perturbative variational calculation of the Helmholtz free energy is based on an ab initio and highly reliable nonlocal pseudopotential. Only limited improvement is found in the calculated thermodynamic functions, even when full advantage is taken of the two variational parameters inherent in this approach. The role of thermodynamic self-consistency between the equations of state of the reference fluid derived from the routes of the internal energy and of the virial theorem is then discussed, using previous results by Hoye and Stell. An approximate evaluation of the corresponding contribution to the free energy of liquid alkali metals yields appreciable improvements in both the thermodynamic functions and the liquid structure factor. It thus appears that an accurate treatment of thermodynamic self-consistency in the charged-hard-sphere system may help to resolve some of the difficulties that are commonly met in the evaluation of thermodynamic and structural properties of liquid metals. (author). 55 refs, 4 figs, 4 tabs.

32806 (LA-UR–90-1338) **Destruction of propellant components in supercritical water.** Buelow, S.J. (Los Alamos National Lab., NM (USA)); Dyer, R.B.; Rofer, C.K.; Atencio, J.H.; Wander, J.D. Los Alamos National Lab., NM (USA). [1990]. 14p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-9003153–1: Workshop on the alternative to open burning/open detonation of propellants and explosives, Panama City, FL (USA), 27-28 Mar 1990). Order Number DE90010600. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Supercritical water oxidation is an innovative, relatively low-temperature process that can give high destruction efficiencies for a wide variety of hazardous chemical wastes. It takes place in a water medium with added oxidant above the critical point of water. In this paper we present preliminary results for the destruction of propellant components in supercritical water without added oxidant. Reactions of ammonium perchlorate and nitromethane are examined using a flow reactor made of Hastelloy C276 operated at temperatures as high as 580°C at pressures near 38.7 MPa. (5500 psig). Over 99.8% of the ammonium perchlorate is destroyed in less than 15 seconds at 500°C. The reaction produces primarily chloride ion, nitrous oxide, and oxygen. A small amount of the nitrogen is converted into nitrate ion and nitrite ion. No reaction is detected in 180 seconds at temperatures below 400°C. For nitromethane, over 99% is destroyed at 500°C within 30 seconds. The reaction produces negligible amounts of nitrate and nitrite. Effluents from both ammonium perchlorate and nitromethane experiments were analyzed for metal ions that could results from corrosion of the reactor.

32807 (PB–90-181280/XAB) **Polychlorinated biphenyls: Progress and problems.** Texas A and M Univ., College Station, TX (USA). c 1985. 13p. Available from NTIS, PC A03/MF A01.

Pub. in Hazardous Contaminants in Ontario: Human and Environmental Effects, Chapter 5, 60-68(1985).

Polychlorinated biphenyls (PCBs) are industrial chemical products which are synthesized by the direct chlorination of biphenyl. The degree of biphenyl ring chlorination determines the physical properties and applications of commercial PCBs and, therefore, it is not surprising that these compounds were marketed and sold according to their chlorine content. For example, Aroclors 1221, 1232, 1242 and 1254 were produced by the Monsanto Chemical Co. and contain 21, 32, 42, and 54% (by weight) chlorine content. Commercial PCBs are distinguished by their stability and resistance to breakdown by acids, bases, oxidation and reduction, their miscibility with numerous organic solvents, their non-flammability and their excellent electrical insulation properties. Because of these highly desirable physical properties PCBs have enjoyed widespread use as industrial fluids, flame retardants, diluents, hydraulic fluids and as dielectric fluids for capacitors and transformers. Although the total world production of commercial PCBs is unknown, the figure is well in excess of 10^9 lbs.

32808 (UCRL-JC–103872) **New surface atomic structures for III-V(110)-p(1×1)-Sb(1ML): Chemical bonding and electronic structure.** LaFemina, J.P. (Pacific Northwest Lab., Richland, WA (USA)); Duke, C.B.; Mailhiot, C. Lawrence Livermore National Lab., CA (USA). Apr 1990. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900466–40: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90011230. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Tight-binding total energy computations are used to examine the chemical bonding and electronic structure for two new minimum-energy surface atomic structures for p(1×1) overlayers of Sb on III-V(110) surfaces. The bonding in each of these structures is unique, having no analog in either the bulk or small molecule coordination chemistry of these materials, and is a phenomena uniquely associated with the constrained epitaxical growth of the Sb overlayer. 13 refs., 2 figs., 2 tabs.

32809 **Revised Eh-pH diagrams (25 C, one bar) for uranium and transuranic elements: Application to radioactive waste studies.** Brookins, D.G. (Dept. of Geology, Univ. of New Mexico, Albuquerque, NM (US)). 161-168 of Materials stability and environmental degradation. Barkatt, A.; Verink, E.D. Jr.; Smith, L.R. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804134–: Symposium on materials stability and environmental degradation, Reno, NV (USA), 5-9 Apr 1988).

Eh-pH diagrams are useful for comparing the probable geochemical behavior of many elements including U and the transuranics Np, Pu, Am. Revised Eh-pH diagrams have been constructed for U, Np, Pu and Am at 25 C, 1 bar conditions. These diagrams, based on new and revised thermodynamic data, include aqueous and solid species in the generic system M-C-O-H. The species $M(OH)^-$ is considered herein, although it's existence has not been verified. The importance of the $M(OH)_4$ precursors to MO_2 species is the enhanced possibility of radionuclide migration from buried spent fuel rods, even under reducing conditions.

32810 **Prediction of glass durability as a function of environmental conditions.** Jantzen, C.M. (E.I. du Pont de Nemours and Co., Savannah River Lab, Aiken, SC (US)). 143-160 of Materials stability and environmental degradation. Barkatt, A.; Verink, E.D. Jr.; Smith, L.R. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract AC09-76SR00001. (CONF-8804134–: Symposium on materials stability and environmental degradation, Reno, NV (USA), 5-9 Apr 1988).

The author reports on thermodynamic model of glass durability applied to natural, ancient, and nuclear waste glasses. The durabilities of over 150 different natural and man-made glasses, including actual ancient Roman and Islamic glasses (Jalame ca. 350 A. D., Nishapur 10-11th century A. D., and Gorgon 9-11th century A.D.), have been compared. Glass durability had been shown to be a function of the thermodynamic hydration free energy. $\Delta\ ^{G}hyd$, which can be calculated from glass composition and solution pH. Using this approach, the durability of the most durable nuclear waste glasses examined was $\simeq 10^6$ years by comparison with the durability of the natural basalts of $\simeq 10^6$ years. The least durable waste glass formulations were comparable in durability to the most durable simulated medieval window glasses of $\simeq 10^3$ years. In this manner, the durability of nuclear waste glasses has been interpolated to be $\simeq 10^6$ years and no less than 10^3 years. Hydration thermodynamics are shown to be applicable to the dissolution of glass in various natural environments. Groundwater-glass interactions relative to geologic disposal of nuclear waste, hydration rind dating of obsidians, and/or other archeological studies can be modeled, e.g. the relative durabilities of six simulated medieval window glasses have been correctly predicted for both laboratory (one month) and burial (5 year) experiments.

32811 **Quantitative theory of sensitization.** Devine, T.M. (Dept. of Materials Science and Mineral Engineering, Univ. of CA,

Berkeley, CA (US)). 235-242 of Materials stability and environmental degradation. Barkatt, A.; Verink, E.D. Jr.; Smith, L.R. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804134--: Symposium on materials stability and environmental degradation, Reno, NV (USA), 5-9 Apr 1988).

The chromium composition along the grain boundaries of sensitized austenitic stainless steel are calculated using several different quantitative theories of sensitization. The results of the calculations are compared to measured values of the chromium composition along the grain boundary in an effort to assess the validity of the various theories. The experimental results point out two facts not previously emphasized in prior studies: the amount of carbide precipitation required to sensitize austenitic stainless steel is small and significant de-sensitization does not occur until after large amounts of carbide precipitation have occurred.

32812 The energetics associated with the formation of interfaces, multilayers and adlayers. Watson, R.E. (Brookhaven National Lab, Bldg 510A, Upton, NY (US)); Weinert, M.; Fernando, G.W.; Davenport, J.W. 405-410 of Atomic scale calculations in materials science. Tersoff, J.; Vanderbilt, D.; Vitek, V. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC02-76CH00016. (CONF-8811147--: Symposium on atomic scale calculations in materials science, Boston, MA (USA), 28-30 Nov 1988).

A combination of bulk and slab total energy calculations have been done to disentangle the energetics of metal adlayer and multilayer formation. This paper presents results obtained for Pd/Nb(110), Pd/Nb(001), Ag/Nb(110), Ag/Nb(001) and Nb/Pd(111). They provide a picture consistent with what isknown experimentally for these systems.

32813 Electrolysis at an anthracene crystal/aqueous NO_3^- solution interface: The role of crystal defects. Pope, M. (New York Univ., NY (USA)); Mao, B.; Steigman, J.; Geacintov, N.E. *Journal of Physical Chemistry (USA),* 94(5): 1719-1720 (8 Mar 1990).

The electrolysis of a 1 M solution of $NaNO_3$ by means of an anthracene crystal electrode results in the production of many surface reaction products, including 9-nitroanthracene (9NA), bianthronyl (BA), and anthraquinone (AQ). The production of 9NA and BA have been shown to depend on the square of the current density. This dependence was rationalized by hypothesizing the need for the simultaneous discharge of two carriers at adjoining lattice defect sites. By annealing the crystals, it was found that the efficiency of producing 9NA was reduced by a factor of as much as 6; this supports the hypothesis.

32814 Infrared spectra of C_2 hydrocarbon ligands coordinated to a triosmium framework: The effect of high pressure as a tool for assignment. Coffer, J.L. (Univ. of Illinois, Urbana-Champaign (USA)); Drickamer, H.G.; Park, J.T.; Roginski, R.T.; Shapley, J.R. *Journal of Physical Chemistry (USA),* 94(5): 1981-1985 (8 Mar 1990). DOE Contract AC02-76ER01198.

The effect of high pressure on the vibrational frequencies of a set of triosmium clusters $(Os_3(CO)_{10})\mu_3$, η^2-C_2H_2 (1), $HOs_3(CO)_9(\mu_3, \eta^2$-CCH) (2), $H_2Os_3(CO)_9(\mu_3, \eta^2$-$CCH_2)$ (3), $H_3Os_3(CO)_9(\mu_3$-$CCH_3)$ (4) has been measured in the range 0-96 kbar. The pressure shifts observed for various infrared bands are used to assign previously uncharacterized bands and to confirm other existing assignments.

32815 Interdroplet attractive forces in AOT water-in-oil microemulsions formed in subcritical and supercritical solvents. Tingey, J.M. (Pacific Northwest Lab., Richland, WA (USA)); Fulton, J.L.; Smith, R.D. *Journal of Physical Chemistry (USA),* 94(5): 1997-2004 (8 Mar 1990). DOE Contract AC06-76RL01830.

The van der Waals attractive interactions between aqueous droplets in water-in-oil type microemulsions have been investigated for a range of continuous-phase solvents including the alkanes from methane to isooctane and the noble gases, krypton and xenon. Hamaker constants for water droplets with surfactant shells of the sodium bis(2-ethylhexyl) sulfosuccinate (AOT) in subcritical and supercritical solvents were calculated by using Lifshitz theory and the resulting interaction potential calculations qualitatively account for many features of the phase behavior of these systems.

32816 Glasses in the system phosphorus-sulfur: A ^{31}P spin-echo and high-speed MAS-NMR study of atomic distribution and local order. Tullius, M. (Univ. of California, Santa Barbara (USA)); Lathrop, D.; Eckert, H. *Journal of Physical Chemistry (USA),* 94(5): 2145-2150 (8 Mar 1990).

The structural organization of glasses in the system P-S is investigated by modern solid-state NMR techniques. Throughout the entire region of glass formation, $S{=}PS_{3/2}$ groups are found to be the principal short-range-order environment. These units are identified, in conjunction with parallel studies of crystalline model compounds, by a characteristic ^{31}P MAS-NMR (MAS = magic angle spinning) sideband intensity pattern, indicating near-to-axial symmetry of the shielding tensor with a maximum shielding component of -60 ppm vs 85% H_3PO_4 parallel to the P=S bond.

32817 Search for a multiproperty empirical intermolecular potential for $XeSF_6$. El-Sheikh, S.M. (Department of Physics, University of Manitoba, Winnipeg, Manitoba, R3T 2N2 Canada (CA)); Tabisz, G.C.; Pack, R.T. *Journal of Chemical Physics (USA),* 92(7): 4234-4238 (1 Apr 1990).

An approximate anisotropic intermolecular potential for the Xe–SF_6 interaction is developed by fitting the Morse–Morse–Morse–Spline–Van der Waals potential form to interaction virial coefficient, diffusion coefficient and collision-induced light scattering data.

32818 A general model of electron spin polarization arising from the interactions within radical pairs. Norris, J.R. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439 (USA)); — Morris, A.L.; Tang, J. *Journal of Chemical Physics (USA),* 92(7): 4239-4249 (1 Apr 1990). DOE Contract W-31109-ENG-38.

We present a general description of electron spin polarization observed for interacting radical pairs. Unlike previous treatments, both chemically induced dynamic electron polarization and correlated radical pair polarization are included for ST_0 mixing. A key feature of this model is that the members of the pair can remain interacting throughout the time sequence of electron spin polarization. Explanations of the time-dependent evolution of the electron spin polarization are presented using the density matrix and its associated vector diagram. A new vector method is formulated for calculating and visualizing chemically induced electron spin polarization. The approach is based on the vector, $\Delta\rho(t)$ which represents the displacement of the density vector $\rho(t)$ from its direction at the time of its "birth." In addition, these electron spin polarization phenomena are described in spectroscopic terms as well as in the usual mathematical manner.

32819 A composition density functional theory for mixtures based upon an infinitely polydisperse reference. II. Freezing in hard sphere mixtures. Kofke, D.A. (Department of Chemical Engineering, University of Pennsylvania, Philadelphia, Pennsylvania 19104-6393 (USA)); Glandt, E.D. *Journal of Chemical Physics (USA),* 92(7): 4417-4425 (1 Apr 1990).

A theory recently proposed by the authors [Kofke and Glandt, J. Chem. Phys. 92, 658 (1990)] is applied to the study of freezing in hard spheres and hard sphere mixtures. The theory, which expresses the free energy of an arbitrary mixture as a functional of the composition density of an infinitely polydisperse (IP) reference, is used to evaluate the properties of mixtures of hard spheres constrained to the Wigner–Seitz cells of an fcc lattice. Semigrand Monte Carlo simulations are used to determine the properties of the IP reference mixture, which is also constrained to an fcc lattice. Freezing is determined by comparing the predicted properties of the Wigner–Seitz crystal with the known properties of the fluid phase. A freezing transition is found for monodisperse hard spheres; the estimated solid-phase density and the transition pressure differ from the accepted values by 2% and 8%, respectively. The treatment is also used to study freezing in polydisperse mixtures with Gaussian distributions of diameters. In accordance with the findings of others, an upper bound is found to the variance of the distribution, beyond which freezing no longer occurs. However, the maximum variance predicted here is approximately one order of magnitude less than that previously found. Discrepancies here

and in the pure-fluid results are attributed largely to ergodic difficulties in the simulations of the IP reference. Finally, the possibility of a phase transition in IP mixtures is demonstrated through a calculation of the freezing point of IP hard spheres.

32820 **Trapping-mediated dissociative chemisorption of ethane on Ir(110)-(1×2).** Mullins, C.B. (Department of Chemical Engineering, University of California, Santa Barbara, California 93106 (USA)); Weinberg, W.H. *Journal of Chemical Physics (USA)*, 92(7): 4508-4512 (1 Apr 1990). DOE Contract FG03-89ER14048.

Evidence is presented to support a trapping-mediated dissociative chemisorption mechanism for ethane interacting with an Ir(110)-(1×2) surface. The data were obtained from supersonic molecular-beam measurements with an incident kinetic energy E_i ranging between 1.2 and 24.1 kcal/mol, a surface temperature T_s between 154 and 500 K, and an incident angle θ_i between 0° and 45°. For E_i less than approximately 13 kcal/mol, the probability of dissociative chemisorption S_0 decreases rapidly with increasing T_s. For a surface temperature of 154 K, S_0 decreases with increasing E_i for $1.2 \leq E_i \leq 13.4$ kcal/mol, consistent with a trapping-mediated chemisorption mechanism. Indeed, the data also support quantitatively a kinetic model consistent with a trapping-mediated chemisorption mechanism. The difference in the activation energies for desorption and chemisorption from the physically adsorbed, trapped state $E_d - E_c$ is 2.2±0.2 kcal/mol. In the trapping-mediated regime, S_0 is found to be rather insensitive to incident angle, scaling with $E_i \cos^{0.5} \theta_i$.

32821 **The origin of small and large molecule behavior in the vibrational relaxation of highly excited molecules.** Gordon, R.J. (Department of Chemistry, University of Illinois at Chicago, Box 4348, Chicago, Illinois 60680 (USA)). *Journal of Chemical Physics (USA)*, 92(7): 4632-4634 (1 Apr 1990).

An explanation is proposed for the qualitatively different types of behavior that have been reported for the vibrational relaxation of highly excited diatomic and polyatomic molecules. It is argued that all of the diatomic molecules that have been studied in bulk relax adiabatically at room temperature. In contrast, large polyatomic molecules have low frequency modes which act at "doorway" modes for the rest of the molecules, producing an impulsive relaxation mechanism. The theoretical work of Nesbitt and Hynes showed that impulsive collisions result in an exponential decay of the average vibrational energy of a Morse oscillator, whereas adiabatic collisions produce nonexponential power law behavior. We propose that this result explains a large body of data for the vibrational relaxation of small and large molecules.

32822 **Gas-phase heats of formation of $C_7H_7^+$ isomers: M-tolyl, p-tolyl, and benzyl ions.** Baer, T. (Univ. of North Carolina, Chapel Hill (USA)); Morrow, J.C.; Shao, Jian Dong; Olesik, S. *Journal of the American Chemical Society (USA)*, 110(17): 5633-5638 (17 Aug 1988).

The dissociation onsets of $C_7H_7^+$ formation from the ionic precursors of benzyl bromide and m- and p-nitrotoluene have been investigated by photoelectron photoion coincidence in order to determine accurate heats of formation of the resulting $C_7H_7^+$ ion structures. These parent ions are known to produce 100% benzyl and tolyl ions, respectively. Because the benzyl bromide ion dissociation was found to be rapid, the dissociation onset was determined from the crossover energy in the breakdown diagram and appropriately corrected for the precursor thermal energy. The nitrobenzene ions dissociate slowly near the dissociation onset, so that the thermochemical onset was found by extrapolating the measured decay rates with the RRKM/QET statistical theory. The rate data indicate that p- and m-nitrotoluene ions do not isomerize to a common structure prior to dissociation. This suggests that, the p- and m-tolyl ions also exist as unique structures. However, no information about the o-tolyl ion was obtained. The derived ionic heats of formation were $\Delta H_f°_{298}$ (m-tolyl) = 1054 ± 10 kJ/mol, $\Delta H_f°_{298}$ (p-tolyl) = 1074 ± 10 kJ/mol, and $\Delta H_f°_{298}$ (benzyl) = 897 ± 5 kJ/mol. An upper limit for the heat of formation of $C_6H_4CH_3O^+$, the NO loss product from the p-nitrotoluene ion, was determined to be 890 kJ/mol. These heats of formation allow the methyl and ring C-H bond energies in the toluene ion to be calculated. They are 2.18 and 3.9 eV respectively. 50 refs., 4 figs., 3 tabs.

32823 **Proton affinities and pK_a values of tetraalkylhydrazines.** Nelsen, S.F. (Univ. of Wisconsin, Madison (USA)); Rumack, D.T.; Sieck, L.W.; Moet-Ner Mautner, M. *Journal of the American Chemical Society (USA)*, 110(19): 6303-6308 (14 Sep 1988).

Proton affinities for 16 saturated tetraalkylhydrazines were determined by equilibration with triethylamine, 2,6-dimethylpyridine, and 2,6-diethylpyridine using high-pressure mass spectrometry, and pK_a measurements in water were made for the 14 compounds which proved sufficiently soluble. Proton-transfer equilibria for these compounds are compared with electron-transfer equilibria previously measured. 17 refs., 5 figs., 3 tabs.

4004 Electrochemistry

Refer also to citation(s) 32813, 32860, 33025, 33198, 33202, 33723

32824 **Mechanistic aspects of reductions by hot electrons in p-InP/acetonitrile photoelectrochemical cells.** Koval, C.A. (Univ. of Colorado, Boulder (USA)); Segar, P.R. *Journal of Physical Chemistry (USA)*, 94(5): 2033-2039 (8 Mar 1990). DOE Contract FG02-84ER13247.

The irreversible supra-band-edge reduction of copper(I) (transdiene)$^+$ to copper metal has previously been used to confirm the existence of hot electron reductions occurring at the p-InP/acetonitrile interface. Results for similar experiments performed over a much wider range of conditions are presented herein. Lower limits for hot electron quantum efficiencies up to 2.6% are measured at high-doped p-InP photoelectrodes.

4005 Photochemistry

Refer also to citation(s) 32279, 32829

32825 (DOE/ER/13942-2) **Photoinduced charge separation by polymer-bound chromophores: Progress report, September 1986–December 1989.** Rodgers, M.A.J. Bowling Green State Univ., OH (USA). Dec 1989. 32p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER13942. Order Number DE90010997. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The major thrust of the project has been to examine the photodynamic behavior of water-soluble polymers that have covalently linked hydrophobic chromophores spaced along the chains. These polymeric systems have been examined for photoinduced charge separation with electron-accepting ions having different total charge. To date focus has been centered on the excited singlet (S_1) state formed by laser flash absorption. The effects of pH and ionic strength – factors that govern the conformational nature of the polymer in solution – have been studied. Most efforts have concerned the effect of such conditions, and of the nature of the chromophore, on the yield of separated charges.

32826 **Does Marcus-Hush theory really work? Optical studies of intervalence transfer in acetylene-bridged biferrocene monocation at infinite dilution and at finite ionic strengths.** Blackbourn, R.L. (Northwestern Univ., Evanston, IL (USA)); Hupp, J.T. *Journal of Physical Chemistry (USA)*, 94(5): 1788-1793 (8 Mar 1990).

Intervalence charge-transfer data for acetylene-bridged biferrocene monocation (Bf^+) have been collected in five solvents in the presence and absence of excess electrolyte and in the limit of infinite chromophore dilution. The study was motivated by earlier work which demonstrated that the intervalence absorption maximum for Bf^+ in methylene chloride could vary substantially with both chromophore concentration and added electrolyte concentration. In the present study similar (but smaller) variations are found in other solvents.

32827 **Surface-enhanced resonance Raman scattering from methylviologen at a silver electrode: Evidence for two distinct adsorption interactions.** Feng, Qiao (Univ. of Nebraska, Lincoln (USA)); Yua, W.; Cotton, T.M. *Journal of Physical Chemistry (USA)*, 94(5): 2082-2091 (8 Mar 1990). DOE Contract FG02-84ER13261.

The electronic absorption and resonance Raman spectra of methylviologen radical cation ($MV^{+\bullet}$) and fully reduced methylviologen (MV^0) have been characterized. The enhancement of Raman and resonance Raman (RR) scattering from the dication and its reduction products at polished and roughened silver electrodes was also investigated.

32828 **Molecular beam studies of the photodissociation of benzene at 193 and 248 nm.** Yokoyama, A. (Materials and Chemical Sciences Division, Lawrence Berkeley Laboratory, Berkeley, CA (USA)—Department of Chemistry, University of California, Berkeley, California 94720 (USA)); Zhao, X.; Hintsa, E.J.; Continetti, R.E.; Lee, Y.T. *Journal of Chemical Physics (USA)*, 92(7): 4222-4233 (1 Apr 1990). DOE Contract AC03-76SF00098.

The photodissociation processes of benzene following excitation at 193 and 248 nm have been studied by molecular beam photofragmentation translational spectroscopy. When benzene was excited to the $^1B_{1u}$ state by absorption at 193 nm, dissociation occurred through three primary channels, C_6H_5+H (80%), $C_6H_4+H_2$ (16%), and $C_5H_3+CH_3$ (4%), following internal conversion to the vibrationally excited ground state. When benzene was excited to the $^1B_{2u}$ state at 248 nm, two primary dissociation channels, $C_6H_4+H_2$ (96%), and $C_5H_3+CH_3$ (4%), were observed. Photodissociation to produce two C_3H_3 was induced by two photon absorption of benzene at both 193 and 248 nm. Numerous secondary photodissociation processes of the primary photoproducts were also observed at both 193 and 248 nm.

4006 Radiation Chemistry

32829 (DOE/ER/00038–3288) **Radiation Laboratory, University of Notre Dame quarterly report, January 1–March 31, 1990.** Notre Dame Univ., IN (USA). 27 Apr 1990. 38p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76ER00038. Order Number DE90010910. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report contains abstracts for reports released from the Radiation Laboratory at the University of Notre Dame during the period of January 1st to March 31st, 1990. (JDL)

32830 **Interaction of ionizing radiation with matter.** Chatterjee, A. (Lawrence Berkeley Lab., Univ. of California at Berkeley, CA (US)). 1-28 of Radiation chemistry: Principles and applications. Farhataziz; Rodgers, M.A.J. VCH Publishers Inc., New York, NY (USA) (1987).

Radiation chemistry is concerned with the interaction of energetic charged particles (electrons, protons, alpha and other particles) and high-energy photons (x-rays and y-rays) with matter. These interactions result in ionization (along with some excitation) of the medium; hence, charged particles, x-rays, and y-rays are frequently called ionizing radiations. In contrast, visible or near ultraviolet photons interact with matter by predominantly producing excited states (even though ionization can also be produced if there is enough energy in the photons). Thus, visible and ultraviolet photons are called nonionizing radiations, and the chemical reactions induced by them are in the domain of photochemistry. In this chapter the authors concentrate on the interaction of ionizing radiation with matter. It is necessary to understand the various processes by which radiations interact with matter, because it is in these processes that energy is transferred to the medium; and this energy absorption leads to the chemical changes of radiation chemistry. The authors attempt to deal with the theory of the physical mechanisms of energy transfer.

32831 **Theoretical aspects of radiation chemistry.** Magee, J.L. (Lawrence Berkeley Lab., Univ. of California at Berkeley, CA (US)); Chatterjee, A. 137-172 of Radiation chemistry: Principles and applications. Farhataziz; Rodgers, M.A.J. VCH Publishers Inc., New York, NY (USA) (1987).

In this chapter the focus is on a theoretical description of the entire sequence of events in irradiated systems, and they are particularly interested in the relationships of the events as they depend on the qualities and energies of the radiations. Throughout this chapter, water has been used extensively in examples. This is done because so much of radiation chemical theory deals with water, perhaps in large part because of this substance's importance in radiation biology.

32832 **Track models and radiation chemical yields.** Chatterjee, A. (Lawrence Berkeley Lab., Univ. of California at Berkeley, CA (US)); Magee, J.L. 173-200 of Radiation chemistry: Principles and applications. Farhataziz; Rodgers, M.A.J. VCH Publishers Inc., New York, NY (USA) (1987).

The authors are concerned only with systems in which single track effects dominate and radiation chemical yields are sums of yields for individual tracks. The authors know that the energy deposits of heavy particle tracks are composed of spurs along the particle trajectory (about one-half of the energy) and a more diffuse pattern composed of the tracks of knock-on electrons, called the penumbra (about one-half of the energy). The simplest way to introduce the concept of a unified track model for heavy particles is to consider the special case of the track of a heavy particle with an LET below 0.2-0.3eV/A, which in practice limits us to protons, deuterons, or particles with energy above 100 MeV per nucleon. At these LET values, to a good approximation, spurs formed by the main particle track can be considered to remain isolated throughout the radiation chemical reactions.

4007 Radiochemistry and Nuclear Chemistry

Refer also to citation(s) 32213, 32829

32833 (IPNO-DRE–89-36) **Electrochemical reduction of actinide ions in aqueous solution and some examples of its application.** David, F. (Paris-11 Univ., 91 - Orsay (FR). Inst. de Physique Nucleaire); Maslennikov, A.G.; Peretrukhin, V.P. Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire. 1989. 18p. Order Number DE90793018. Available from NTIS (US Sales Only), PC A03/MF A01.

Electrochemical reduction of heavy elements from aqueous solution to amalgams was studied by radiopolarography and radiocoulometry methods. Mechanism of actinide reduction on a mercury pool is discussed through simulation technics. Special emphasis is pointed out to redox reactions and potentials, kinetics of the process and effect of acetete and citrate ions as complexing agents. Three groups of actinides have been found out. (1) actinium and from uranium to berkelium: Reduction occurs in the experimental conditions via an irreversible 3-0 process. (2) from fermium to nobelium, which are reduced in non complexing solutions, or with acetate ions, similarly as baryum and radium, via a reversible 2-0 reaction. (3) californium and einsteinium behave as intermediate elements. Several examples of electrochemical application are presented. Californium has been separated from precedent transuranium and lanthanides (except europium) by electrochemical reduction to amalgams in acetic solution. Separation factors from 25-90 are achieved. Similarly, this element could be separated from several heavier actinides with citric media. The electrochemical preparation of mixed uranium-nickel and uranium-tin amalgams from aqueous acetate solutions is investigated. The dependence of redox potentials of mixed amalgams on different atomic ratio U:Ni and U:Sn in amalgams is measured. The distillation of mercury from mixed amalgams with different atomic ratios U:Ni and U:Sn is carried out and the products are identified by chemical analysis and X-ray diffraction. The intermetallics UNi_5 and USn_3 are prepared from mixed amalgams. The uranium and neptunium amalgams are prepared by electrolysis of aqueous acetate solutions and are processed into metals or nitrides U_2N_3, NpN by distillation in vacuum or in nitrogen atmosphere. 42 refs.

32834 **Reduction of UO_{2+x} by atomic hydrogen.** Abrefah, J. (Lawrence Berkeley Lab., CA (USA)); Dooley, D.F.; Olander, D.R. *Journal of Physical Chemistry (USA)*, 94(5): 1937-1944 (8 Mar 1990). DOE Contract AC03-76SF00098.

The modulated molecular beam technique with in situ mass spectrometric phase sensitive detection was used to study the kinetics of atomic hydrogen reduction of hyperstoichiometric uranium dioxide. The atomic hydrogen portion of an incident mixed-collisionless H/H_2 beam chemisorbed onto urania surface with a sticking probability of 0.7 ± 0.1. A major fraction of the

chemisorbed H atom recombined to produce H_2 gas, and only a small fraction entered the parallel channel leading to water production. A phenomenological model was fitted to the data.

4008 Combustion, Pyrolysis, and High-Temperature Chemistry

Refer also to citation(s) 32076, 32119, 32145, 32167, 32437, 32519, 32520, 32789, 32880

32835 (CONF-900704–9) **The roles of PAH [polycyclic aromatic hydrocarbons] and acetylene in soot nucleation and growth.** McKinnon, J.T.; Howard, J.B. Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Chemical Engineering. [1990]. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER13282. From 23. Combustion Institute symposium on combustion; Orleans (France); 22-27 Jul 1990. Order Number DE90009022. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Soot nucleation and growth mechanisms involving PAH and C_2H_2 in distinct roles were quantitatively tested against experimental data including profiles of soot, PAH, C_2H_2 and other species present in flat benzene/oxygen/argon flames at 20 and 40 torr and equivalence ratios of 2.0, 2.125, and 2.4. In all the flames, the concentration of high molecular weight PAH was found to exhibit a maximum value near the onset of soot nucleation and to decline in the nucleation zone. A nucleation mechanism involving growth by reactive coagulation of heavy PAH in competition with destruction through OH attack gave good agreement between measured and predicted features of the soot nucleation kinetics. Conversely, soot nucleation through the growth of PAH by sequential addition of C_2H_2 with no PAH-PAH coagulation was much too slow to agree with data. PAH also contribute significantly to the post-nucleation growth of soot particles. Most of the mass of the soot system appears to come from C_2H_2 through the formation of the heavy PAH precursors to soot nuclei and the PAH that add to the growing soot particles, and direct C_2H_2 addition to the soot. Both the growth and oxidation reactions in these mechanisms are formulated as involving localized σ-radicals (i.e. aryl radicals in the case of PAH and active sites in the case of soot). The fraction of aryl radicals in the PAH and of active sites among carbon atoms of the soot surface are assumed to depend on a partial equilibrium involving the gas-phase concentration of H and H_2. The decrease in the surface growth rate of soot with time can be attributed in part to the decay in gas-phase concentration and a reduction in the hydrogen content of the soot. 29 refs., 5 figs., 3 tabs.

32836 (UCRL–102584) **A numerical study of silane combustion.** Britten, J.A.; Tong, J.; Westbrook, C.K. Lawrence Livermore National Lab., CA (USA). Dec 1989. 17p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-7405-ENG-48. (CONF-900704–4: 23. Combustion Institute symposium on combustion, Orleans (France), 22-27 Jul 1990). Order Number DE90006002. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A kinetic model of the mechanism of silane combustion has been developed, using a system of 70 elementary reaction steps and 25 chemical species. The model was used to examine silane ignition at ordinary pressures under both shock tube conditions and low-temperature constant-volume conditions. The agreement between model predictions and experimental data is very good, both with respect to shock tube ignition delay times and to the pronounced, nonlinear variation of autoignition time with initial pressure at near-ambient temperatures. The model also reproduces observed trends in H_2/H_2O product yield as a function of the initial SiH_4/O_2 ratio. One key to this mechanism is competition between thermal stabilization and chain-branching decomposition reactions of an excited-state silylperoxy radical, and a second key is the reaction of water vapor with intermediate species containing a Si=O double bond. 27 refs., 4 figs., 2 tabs.

32837 (UCRL–102778) **Auto-ignition temperatures of binary mixtures of alkanes in a closed vessel: Comparisons between experimental measurements and numerical predictions.** Griffiths, J.F. (Leeds Univ. (UK). School of Chemistry); Coppersthwaite, D.; Phillips, C.H.; Westbrook, C.K.; Pitz, W.J. Lawrence Livermore National Lab., CA (USA). [1990]. 22p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-7405-ENG-48. (CONF-900704–8: 23. Combustion Institute symposium on combustion, Orleans (France), 22-27 Jul 1990). Order Number DE90007856. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Autoignition temperatures of the binary mixtures methane + ethane and methane + butane in air were measured at atmospheric pressure in a 0.56 dm^3 spherical reaction vessel. The method used followed that for standard ASTM and BS tests for gaseous fuels. Fixed proportions by volume of the total fuel in air were studied, which correspond at the extreme of each composition range to the equivalence ratios for methane, ethane and butane of ϕ = 0.93, 1.63 and 3.04, respectively. Supplementary experiments were carried out on butane alone under the same conditions, in which its proportion was varied in the equivalence range $0<\phi<3.04$. The autoignition of methane was sensitized by ethane most strongly when the ethane was present at up to 10% of the total fuel. The autoignition temperature ($T_{a,cr}$) was reduced by 40 K with respect to that for pure methane ($T_{a,cr}$ = 900 K). There was an even stronger sensitization by similar proportions of butane added to methane, such that $T_{a,cr}$ decreased to 810 K. in neither case were the effects linearly dependent on the proportion of additive. There was an addition sensitive region when butane was present in the proportion 0.5–0.7 of the methane/butane mixture, at which $T_{a,cr}$ fell sharply by 50 K over this limited composition range. Remarkably, except at the leanest mixtures ($\phi_{butane} < 0.5$), the autoignition temperatures of compositions containing butane alone matched very closely the autoignition temperatures of the equivalent methane/butane mixtures. We believe that this is a new and very important observation in relation to the understanding and interpretation of combustion hazards involving mixtures of fuels. 28 refs., 4 figs.

32838 **The importance of thermodynamics to the modeling of nitrogen combustion chemistry.** Martin, R.J. (Lawrence Berkeley Lab., CA (USA). Applied Science Div. (USA)); Brown, N.J. *Combustion and Flame (USA)*, 78(3): 365-376 (Dec 1989). DOE Contract AC03-76SF00098.

Modeling calculations have been performed and are presented in the paper to illustrate the effect of using five commonly accepted data bases of thermochemical properties on predictions of temporal species profiles. The thermochemical properties are those used for the determination of equilibrium constants employed in the calculation of reverse rate coefficients for a chemical mechanism where forward rate coefficients are specified. The modeling study was performed for hydrogen/oxygen/argon/nitrogen-compound mixtures where the nitrogen compound was with NO or NH_3. The mixtures reacted isothermally at 1600 K and isobarically at 1 atmosphere, and a single kinetic mechanism for which forward rate coefficients were specified was used throughout. Mixtures of equivalence ratios of 0.625, 1.0, and 1.6 were considered.

32839 **Calculation of vibrational-energy-transfer quantities at high temperatures. Energy and temperature dependence.** Tardy, D.C. (Univ. of Iowa, Iowa City (USA)); Rabinovitch, B.S. *Journal of Physical Chemistry (USA)*, 94(5): 1876-1881 (8 Mar 1990). DOE Contract FG02-87ER13700.

An improved correlation between the energy-transfer quantities $(\Delta E)_{all}$ and $(\Delta E)_d$ has been compared to a widely used approximate expression as a function of temperature and pressure with special reference to the reported unimolecular thermal decomposition of cyclohexene. It is found that significant deviation between the two expressions can arise at high temperature (2000 K) and low pressures. Specification of the average energy level of colliding molecules is a necessary input for this correlation under some experimental conditions. The difficulty encountered in making such a specification for the falloff region is pointed out. These considerations are particularly relevant in high-temperature systems such as shock tubes, flame, and combustion.

32840 **Experimental and theoretical studies of the C_2H_5 + O_2 reaction kinetics.** Wagner, A.F. (Argonne National Lab., IL (USA)); Slagle, I.R.; Sarzynski, D.; Gutman, D. *Journal of Physical Chemistry (USA)*, 94(5): 1853-1868 (8 Mar 1990).

The thermal reaction between C_2H_5 and O_2, which yields both $C_2H_5O_2$ and C_2H_4 + HO_2, has been studied both experimentally

and theoretically. The experiments were conducted in a heatable tubular reactor coupled to a photoionization mass spectrometer. C_2H_5 was produced by homogeneous 193- or 248-nm photolysis of suitable precursors. C_2H_5 decay and C_2H_4 growth profiles were recorded in time-resolved experiments. The measured reaction parameters include second-order rate constants for the loss of C_2H_5 and the product branching ratio, $[C_2H_4]/([C_2H_5O_2] + [C_2H_4])$. Buffer gas (primarily He) pressures from 0.5 to 15 Torr were used. The theoretical study involved modeling the kinetics of the reaction with a coupled mechanism, one in which the reactive routes both begin by the reversible formation of a chemically activated $C_2H_5O_2^*$ adduct.

42 ENGINEERING

4202 Facilities, Equipment, and Techniques

Refer also to citation(s) 32198, 32468, 32496, 32497, 32862, 32942, 32965, 32988, 33037, 33184, 33846

32841 (CEA-CONF-9979) **Adsorption in cryogenics.** Ravex, A. CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Recherche Fondamentale. 1989. 13p. (In French). (CONF-8903213–: Meeting of University Group of Thermics, Paris (France), 22 Mar 1989). Order Number DE90784648. Available from NTIS (US Sales Only), PC A03/MF A01.

There are two main fields for application of physical adsorption in cryogenics: cryopumping and refrigeration. Cryopumping has known many developments but is now almost industrial. Basic principles, applications and realizations are presented, for instance, in nuclear fusion and particle physics. For refrigeration developments and realizations are rare but present potential space applications.

32842 (CONF-900617–14) **Characterization of high damping bearings and their responses to earthquake motions.** Wu, Ting-shu; Seidensticker, R.W. Argonne National Lab., IL (USA). [1990]. 8p. Sponsored by National Science Foundation. From Pressure vessels and piping conference: be in tune for the 90's; Nashville, TN (USA); 17-21 Jun 1990. Order Number DE90011171. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Agreement No. CES-8800871.

An isolation system consisting of six (6) laminated high-damping rubber bearings has been installed in a test facility on the Tohoku University site in Sendai, Japan. The isolation system is designed to have a frequency of 0.75 Hz. This frequency, however, is obtained only when there is a strong earthquake, resulting in significant horizontal displacements. After the installation of this system, in April 1989, static and dynamic tests were performed to obtained fundamental dynamic response properties of the system. The day after these tests were completed, an earthquake of magnitude M = 4.9 occurred in the area. The maximum acceleration experienced by the building was only about 0.03 g. Several other earthquakes have occurred since then, all of which resulted in low input acceleration at the Tohoku facility. Analytical investigations for the building have been carried out using a model with stiffness and damping of the isolation system obtained from the in-situ tests. Response of the simulated model to this earthquake show good agreement with the recorded data at each floor of the isolated building. Both the recorded data and the analytical results indicate that the bearings installed in this building are stiff enough to prevent drift of the superstructure under minor tremors or wind loads. Results of all in-situ tests are presented. 5 refs., 10 figs., 1 tab.

32843 (CONF-900729–1) **Experimentation and concept formation by an autonomous mobile robot.** Spelt, P.F.; deSaussure, G.; Oliver, G.; Silliman, M. Oak Ridge National Lab., TN (USA). 1990. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Japan-USA symposium on flexible automation; Kyoto (Japan); 9-11 Jul 1990. Order Number DE90003063. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Center for Engineering Systems Advanced Research (CESAR) conducts basic research in the area of intelligent machines. In this paper, we describe our approach to a class of machine learning which involves autonomous concept formation using feedback from trial-and-error experimentation with the environment. Our formulation was experimentally validated on an autonomous mobile robot, which learned the task of control panel monitoring and manipulation for effective process control. Conclusions are drawn concerning the applicability of the system to a more general class of learning problems, and implications for the use of autonomous mobile robots in hostile and unknown environments are discussed. 11 refs., 7 figs.

32844 (CONF-900729–2) **Ultrasound and visual sensor feedback and fusion.** Beckerman, M.; Barnett, D.L.; Killough, S.M. Oak Ridge National Lab., TN (USA). [1990]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Japan-USA symposium on flexible automation; Kyoto (Japan); 9-11 Jul 1990. Order Number DE90005280. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The HERMIES-IIB mobile robot developed at Oak Ridge National Laboratory's (ORNL's) Center for Engineering Systems Advanced Research was designed to carry out autonomous sensing, navigation and manipulation tasks in an unstructured laboratory environment. In this paper we report on the use of sensor feedback and sensor fusion as means of compensating for HERMIES-IIB sensor and mechanical errors, uncertainties and limitations. 7 refs., 9 figs.

32845 (CONF-900780–2) **Performance of multiple tasks by an autonomous robot using visual and ultrasound sensing.** Beckerman, M. (Oak Ridge National Lab., TN (USA)); Barnett, D.L.; Dickens, M.; Weisbin, C.R. Oak Ridge National Lab., TN (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From ISRAM '90: international symposium on robotics and automation; Vancouver (Canada); 18-20 Jul 1990. Order Number DE90010719. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

While there have been many successful mobile robot experiments, only a few papers have addressed issues pertaining to the range of applicability, or robustness, of robotic systems. The purpose of this paper is to report results of a series of benchmark experiments done to determine and quantify the robustness of an integrated hardware and software system of a mobile robot. 5 refs., 6 figs.

32846 (CONF-900780–3) **Optimal positioning of redundant manipulator-platform systems for maximum task efficiency.** Pin, F.G.; Culioli, J.C. Oak Ridge National Lab., TN (USA). [1990]. 8p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From ISRAM '90: international symposium on robotics and automation; Vancouver (Canada); 18-20 Jul 1990. Order Number DE90011061. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Mobile manipulators are attracting significant interest in the industrial, military and public service communities because of the potential they provide for increased efficiency in material handling and manipulation tasks. Corresponding interest has arisen in the robotic research community since the combination and coordination of the mobility of an autonomous platform with the robotic motion of a manipulator introduce complex problems. This paper focuses on a subset of these problems, namely the utilization of the redundancy occurring in most mobile manipulators to optimize their initial positioning and configuration in the accomplishment of given tasks. Optimization schemes are developed for cases when force and position constraints are applied at the end-effector. Various optimization criteria are investigated for optimizing the position of the platform and the configuration of the manipulator with respect to obstacle avoidance, maneuverability and several torque functions. Sample results are presented for a system involving a three-link manipulator on a mobile platform. The various optimization schemes are discussed and compared, and several directions including multi-criteria optimization, tunneling algorithms, and minimax optimization are outlined for further extensions of the methods to the general problem of optimal positioning and configuring of redundant robotic systems with combined mobility and manipulation capabilities. 12 refs.

32847 (CONF-900795–1) **Multi-criteria position and configuration optimization for redundant platform/manipulator systems.** Pin, F.G.; Culioli, J.-C. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From IROS '90: IEEE international workshop on intelligent robots and systems; Tsuchiura (Japan); 3-6 Jul 1990. Order Number DE90010705. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An important characteristic of practical mobile manipulators, i.e., manipulators mounted on mobile platforms, is their particular kinematic redundancy created by the addition of the degrees of freedom of the platform to those of the manipulator. This paper is concerned with the resolution of this kinematic redundancy, and in particular with the local optimization of the position and configuration on the system during task commutations when changes occur in both task requirements and task constraints. Optimization criteria for obstacle avoidance, manupulablity, least torque norm and maximum actuator torque are first discussed. Emphasis is them placed on optimization methods for problems involving multi-requirements and multi-criteria optimization. Sample results of the methods for a system including a three-link manipulator mounted on a mobile platform are presented and discussed. 10 refs., 6 figs.

32848 (EGG-M–89148) **Sensing of metal-transfer mode for process control of GMAW [gas metal arc welding].** Carlson, N.M.; Johnson, J.A.; Smartt, H.B. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC07-76ID01570. (CONF-890770–9: 16. annual review of progress in quantitative nondestructive evaluation, Brunswick, ME (USA), 23-28 Jul 1989). Order Number DE90010946. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

One of the requirements of a sensing system for feedback control of gas metal arc welding (GMAW) is the capability to determine the metal-transfer mode. Because the operating boundary for the desired transfer mode, expressed as a function of mass input and heat input, may vary due to conditions beyond the control of the system, a means of detecting the transfer mode during welding is necessary. A series of sensing experiments was performed during which the ultrasonic emissions, audio emissions, welding current fluctuations and welding voltage fluctuations were recorded as a function of the transfer mode. In addition, high speed movies (5000 frames/s) of the droplet formation and detachment were taken synchronously with the sensing data. An LED mounted in the camera was used to mark the film at the beginning and end of the data acquisition period. A second LED was pulsed at a 1 kHz rate and the pulses recorded on film and with the sensor data. Thus events recorded on the film can be correlated with the sensor data. Data acquired during globular transfer, spray transfer, and stiff spray or streaming transfer were observed to correlate with droplet detachment and arc shorting. The audio, current, and voltage data can be used to discriminate among these different transfer modes. However, the current and voltage data are also dependent on the characteristic of the welding power supply. 5 refs., 3 figs., 1 tab.

32849 (KURRI-TR–319, pp. 39-47) **Development of the criticality accident analysis code, AGNES.** Nakajima, Ken (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment). Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. May 1989. (In Japanese). (CONF-8808287–: 3. KURRI symposium on criticality safety, Kumatori (Japan), 8 Aug 1988). In *Proceedings of the 3rd KURRI symposium on criticality safety.* Order Number DE90741372. Available from NTIS (US Sales Only), PC A05/MF A01.

In the design works for the facilities which handle nuclear fuel, the evaluation of criticality accidents cannot be avoided even if their possibility is as small as negligible. In particular in the system using solution fuel like uranyl nitrate, solution has the property easily becoming dangerous form, and all the past criticality accidents occurred in the case of solution, therefore, the evaluation of criticality accidents becomes the most important item of safety analysis. When a criticality accident occurred in a solution fuel system, due to the generation and movement of radiolysis gas voids, the oscillation of power output and pressure pulses are observed. In order to evaluate the effect of criticality accidents, these output oscillation and pressure pulses must be calculated accurately. For this purpose, the development of the dynamic characteristic code AGNES (Accidentally Generated Nuclear Excursion Simulation code) was carried out. The AGNES is the reactor dynamic characteristic code having two independent void models. Modified energy model and pressure model, and as the benchmark calculation of the AGNES code, the results of the experimental analysis on the CRAC experiment are reported. (K.I.).

32850 (KURRI-TR–319, pp. 1-8) **Spatial dependence of the spectral-ratio in Mihalczo method.** Yamane, Yoshihiro (Nagoya Univ. (Japan). Faculty of Engineering); Suzuki, Yoshiaki; Nishina, Kojiro. Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. May 1989. (In Japanese). (CONF-8808287–: 3. KURRI symposium on criticality safety, Kumatori (Japan), 8 Aug 1988). In *Proceedings of the 3rd KURRI symposium on criticality safety.* Order Number DE90741372. Available from NTIS (US Sales Only), PC A05/MF A01.

The subcriticality determination technique based on ^{252}Cf-source-driven neutron noise measurement, proposed by J.T. Mihalczo at the Oak Ridge National Laboratory (ORNL), is a hopeful method for monitoring of a complex processing environment in such facilities as reprocessing plant. In the present study, data provided by Mihalczo et al. are analyzed to determine the performance of the Mihalczo method. Information on the spatial dependence of the spatial ratio obtained from the analysis is described. Equations based on a modal development method that takes the spatial dependence into account is applied to the data to examine the suitability of the equations for predicting the spatial dependence of the spectral ratio. These investigations show that a strong spatial dependence occurs with particular arrangements of detectors, that the dependence increases with the degree of subcriticality, and that the effective multiplication factor measured with a proper detector arrangement agrees with Monte Carlo calculations. It is also revealed that the above-mentioned equations can explain the dependence of the spectral ratio on the detector arrangement. (N.K.).

32851 (KURRI-TR–319, pp. 13-19) **Subcriticality monitering method based on the count-rate ratio.** Nakamura, Hisashi (Fuji Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. May 1989. (In Japanese). (CONF-8808287–: 3. KURRI symposium on criticality safety, Kumatori (Japan), 8 Aug 1988). In *Proceedings of the 3rd KURRI symposium on criticality safety.* Order Number DE90741372. Available from NTIS (US Sales Only), PC A05/MF A01.

The report proposes a method to determine or predict the multiplication factor of a nuclear fuel system in a subcritical state from a measured count-rate ratio (spectral index) of neutrons. The major feature of the method is that it incorporates the concept of effective count-rate ratio (ECRR) and a data correction (reactivity calibration) technique based on that ratio. Theoretical grounds and procedures for the ECRR method are outlined and descriptions are made of the functions of the subcriticality monitoring equipment, its introduction to an operating plant, mathematical techniques for on-line monitoring, and arrangement of paired detectors. The monitor can perform on-line measurement of the count-rate ratio in a subcritical state, determination of the effective multiplication factor based on regression analysis, and prediction of the effective count-rate ratio in the subsequent state. The last function is the greatest advantage of the ECRR method. When installed at proper positions, paired detectors can work effectively in a fast system, but not when they are situated at the center of a thermal system. (N.K.).

32852 (LA-UR–90-1333) **Interaction of objects in manufacturing process simulation.** Hodge, C.A.; Silbar, R.R.; Knudsen, P.D. Los Alamos National Lab., NM (USA). 17 Apr 1990. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900793–2: AAAI '90: 8. national conference on artificial intelligence, Boston, MA (USA), 29 Jul - 3 aug 1990). Order Number DE90010599. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

To provide generic methodology for discrete-event simulation of manufacturing processes, object-oriented programming techniques have been employed to aid in code clarity, efficient development,

and maintenance. This paper discusses the interaction between objects. The objects are independent of one another relative to internal coding, but maintain a standard communication protocol. Specific examples using the Rocky Flats Plant Simulation developed by group A-7 are presented. 3 refs., 1 fig.

32853 (ORNL/TM–11510) **Time optimal trajectories for a two wheeled robot.** Reister, D.B. Oak Ridge National Lab., TN (USA). May 1990. 29p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. (CESAR–90/12). Order Number DE90010335. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Our objective is to move a two wheeled robot from one posture to the next in the minimum time in a planar environment without obstacles. We assume that the maximum acceleration on each wheel is bounded. We have used Pontryagin's Maximum Principle to find the optimum paths. The optimal trajectories are bang-bang; at every point on the optimum path the acceleration on each wheel is either at the upper limit or at the lower limit. We can use a coordinate transformation to move the initial posture to the origin. We can reach any point by a rotation followed by a translation. Adding a final rotation moves the robot to an arbitrary posture. A switch point is a point at which the acceleration on one of the wheels changes sign. We can characterize a trajectory by the number of switch points. A path with a smaller number of switch points will have a higher average velocity and a longer distance traveled by the wheels. The path with the smallest number of switch points has two (one of each wheel). [For translation, both wheels accelerate from zero to the maximum velocity. After the switch point, both wheels decelerate to zero.] However, there are only two paths with two switch points: translation and rotation. Rotation followed by translation requires five switch points, while rotation, translation, rotation has eight switch points. We have explored paths with three and four switch points. The paths with three switch points and initial rotation can reach any point faster than a rotation followed by a translation. Paths with three switch points and initial translation or paths with four switch points are useful if the final orientation is considerably different than the direction of travel. 5 refs., 11 figs., 6 tabs.

32854 (PB–90-863986/XAB) **Cryogenic refrigeration. March 1982-March 1990 (A Bibliography from the NTIS data base). Report for March 1982-March 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 120p. Available from NTISPC N01/MF N01.

Supersedes PB–89-859276.

This bibliography contains citations concerning the technological development and use of cryogenic-refrigeration methods and equipment. Performance evaluations of specific systems, equipment descriptions and applications, including the cooling of instrumentation, superconductors, reactor devices, satellites, and other spaceborne vehicles are considered. (This updated bibliography contains 224 citations, 27 of which are new entries to the previous edition.)

32855 (SAND–89-2500) **Using the XPATHS computer code.** Cable, G.D. Sandia National Labs., Albuquerque, NM (USA). Sep 1989. 51p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90010324. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An algorithm and a computer program are described for use in determining the geographic locations common between the orbit paths of two satellites or between different portions of a single satellite's orbital path. The method selected uses semi-inertial geometric constructions to determine the crossing locations. 6 refs.

32856 (SAND–89-2561C) **Archimedes: An experiment in automating mechanical assembly.** Strip, D. (Sandia National Labs., Albuquerque, NM (USA)); Maciejewski, A.A. Sandia National Labs., Albuquerque, NM (USA). [1990]. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900780–1: ISRAM '90: international symposium on robotics and automation, Vancouver (Canada), 18-20 Jul 1990). Order Number DE90009001. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Archimedes is a prototype mechanical assembly system which generates and executes robot assembly programs from a CAD model input. The system addresses the unrealized potential for flexibility in robotic mechanical assembly applications by automating the programming task. Input is a solid model of the finished assembly. Using this model, Archimedes deduces geometric assembly constraints and then produces an assembly plan that satisfies the geometric constraints, as well as other constraints such as stability and accessibility. A retargetable plan compiler converts the generic plan into robot and cell specific code, including recognition routines for a vision system. In the prototype system the code is executed in a workcell containing an Adept Two robot, a vision system, and other parts handling equipment. 8 refs., 2 figs.

32857 (SAND–90-0348C) **Sensor-based automated docking of large payloads.** Drotning, W.D. Sandia National Labs., Albuquerque, NM (USA). [1990]. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900608–17: American Nuclear Society annual meeting, Nashville, TN (USA), 10-14 Jun 1990). Order Number DE90011020. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A multiple degree of freedom robotic system is described for the sensor-based, automated remote manipulation and precision docking of large payloads. Computer vision and ultrasonic proximity sensing are used to control the automated precision docking of a large object with a passive target cavity. Real-time sensor processing and model-based analysis are used to control payload position to a precision of ±0.5 mm. 1 ref., 10 figs.

32858 (SAND–90-0352C) **Model based, sensor directed remediation of underground storage tanks.** Christensen, B.; Drotning, W.; Thunborg, S. Sandia National Labs., Albuquerque, NM (USA). [1990]. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900608–18: American Nuclear Society annual meeting, Nashville, TN (USA), 10-14 Jun 1990). Order Number DE90011025. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Sensor rich, intelligent robots which function with respect to models of their environment have significant potential to reduce the time and cost for the cleanup of hazardous waste while increasing operator safety. Sandia National Laboratories is performing experimental investigations into the application of intelligent robot control technology to the problem of removing waste stored in tanks. This paper describes the experimental environment employed at Sandia with particular attention to the computing and software control environment. Intelligent system control is achieved through the integration of extensive geometric and kinematic world models with real-time sensor based control. All operator interactions with the system are through fully animated, graphical representations which validate all operator commands before execution to provide for safe operation. Sensing is used to add information to the robot system's world model and to allow sensor based servo control during selected operations. The results of a first Critical Features Test are reported and the potential for applying advanced intelligent control concepts to the removal of waste in storage tanks is discussed. 4 refs., 9 figs.

32859 **Plug valve.** Wordin, J.J. To Dept. of Energy, Washington, DC. USA Patent 4878652/A/. 7 Nov 1989. Filed date 9 May 1986. USA Patent Application 6-861,383. Int. Cl. F16K 25/00. 6p.

This patent describes an improved plug valve wherein a novel shape for the valve plug and valve chamber provide mating surfaces for improved wear characteristics. The novel shape of the valve plug is a frustum of body of revolution of a curved known as a tractrix, a solid shape otherwise known as a peudosphere.

4204 Heat Transfer and Fluid Flow

Refer also to citation(s) 32939, 32503, 32701, 32709, 32838, 33261, 33788

32860 (CONF-900704–6) **Initial studies of electric field effects on ceramic powder formation in flames.** Katz, J.L.; Hung, Cheng-Hung. Johns Hopkins Univ., Baltimore, MD (USA). Dept. of Chemical Engineering. Dec 1989. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER45356. From 23.

Combustion Institute symposium on combustion; Orleans (France); 22-27 Jul 1990. Order Number DE90007571. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The effect of an electric field on ceramic powder formation was studied in a counterflow diffusion flame burner. $TiCl_4$, SiH_4, $SiCl_4$, and $GeCl_4$ were used as source materials for the formation of TiO_2, SiO_2, and GeO_2 in H_2/Ar-O_2/Ar flames. Particle size and number density were determined using dynamic light scattering measurements and 90° light scattering measurements. The effects of the electric field on flame temperature, current, OH emission intensity, and particle characteristics were measured. The results show that in the presence of an electric field, the peak temperature shifts toward the oxidizer side, and the peak OH emission intensity decreases at low field strengths. Particle diameter and number density measurements show that a factor of 3 change in size can be achieved. These results suggest that an electric field can be successfully used as a control variable in the formation of ceramic oxide powders. 12 refs., 7 figs.

32861 (CONF-900704–7) **Modelling of flamelet surface-to-volume ratio in turbulent premixed combustion.** Cant, R.S.; Pope, S.B.; Bray, K.N.C. Massachusetts Inst. of Tech., Cambridge, MA (USA). [1990]. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13553. From 23. Combustion Institute symposium on combustion; Orleans (France); 22-27 Jul 1990. Order Number DE90006312. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A model is proposed, valid in the laminar flamelet regime, for the surface-to-volume ratio of a turbulent premixed flame. The new model is in a form suitable for incorporation into an existing model of turbulent premixed combustion. Exact equations are derived which describe the dynamics of the constant-property surface representing the flame interface. Unknown terms in the exact equations are modelled for the simplified case of constant-density combustion in a specified turbulence field. Numerical solutions of the modelled equations are carried out for a one-dimensional test case. Preliminary results indicate that the model is capable of predicting effects present in turbulent flame propagation, and a parametric study shows that correct trends are observed. 10 refs., 4 figs.

32862 (CONF-9005168–1) **Parametric study of electrostatically charged sprays.** Barnhart, J.S. (Illinois Univ., Urbana, IL (USA). Dept. of Mechanical and Industrial Engineering); Durbin, T.E.; Peters, J.E.; Leong, K.H. Argonne National Lab., IL (USA). Dec 1989. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 4. annual conference on liquid atomization and spray systems; Hartford, CT (USA); 20-23 May 1990. Order Number DE90010580. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Electrostatically charged sprays are used in a wide range of applications. They include the coating of surfaces as with paint spraying, the production of fine powders and the control of pollutants. The phenomenon of electrostatic spraying has been much researched particularly for the cases of dielectric fluids in paint spraying and conductive fluids in fine metallic powder production. although the literature on electrostatic spraying is voluminous, the parametric dependence of the size distribution of the spray under various conditions still lacks precise definition. The focus of this study is the generation of charged water droplets for the production of ions and radicals in flue gases by pulsed corona discharges to control SO_2 and NO_x. As a first step in evaluating charged sprays for such use, a laboratory-scale injection system was evaluated by measuring atomization performance of needle injectors over a wide range of parameters. Sauter mean diameter (SMD) determined with a Phase/Doppler Particle Analyzer (PDPA) was used as the measure of atomization performance. The independent parameters investigated include applied voltage, needle size, flow rate and $NaNO_3$ concentration (used to vary the solution conductivity). Because the spray was only about 2 mm wide at the sampling point, SMD measured at a single location was taken to be representative of the spray. This assumption was tested by taking radial traverses through the spray. Current flow from the needle to a collector plate 6 cm below was measured with and without solution flow to quantify the relative current-carrying capacities of the spray and the surrounding air. 4 refs., 6 figs.

32863 (EGG-EAST–8680) **Verification and benchmarking of ABAQUS and PATRAN for heat transfer applications.** Hawkes, G.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). Aug 1989. 12p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90010928. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report contains the verification and benchmarking performed at the Idaho National Engineering Laboratory (INEL) on ABAQUS and PATRAN for heat transfer calculations. ABAQUS and PATRAN were used to perform the thermal analysis of the Advanced Test Reactor (ATR) loop 2A piping components. These codes are commercially available and are used extensively within the industry to solve structural and heat transfer problems using finite element methods. They have been extensively verified and documented by the companies developing and providing them. This report documents work performed by EG&G Idaho Inc. to further verify that ABAQUS and PATRAN properly solve a variety of heat transfer problems and that performance on the INEL computers was the same as on the developer's computers. Methods employed to verify ABAQUS and PATRAN are presented within this report. Heat transfer problems with known exact solutions are compared to ABAQUS results. Computer output from the ABAQUS introductory workbook was compared to calculations performed on INEL computers using the same input deck. The verification of ABAQUS and PATRAN at INEL has shown the codes applicable to solve heat transfer problems encountered at INEL. 7 refs., 2 figs., 2 tabs.

32864 (FRCEA-TH–235) **Study of a magnetic refrigeration cycle by active regeneration between 15 and 4.2 kelvins.** Bredy, P. CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Recherche Fondamentale. 1989. 181p. (In French). Order Number DE90784654. Available from NTIS (US Sales Only), PC A09/MF A01.

Magnetic refrigeration with active regeneration cycles was realized on a test bench. From a hot source at 14K cold power near 20 mW is reached on liquid helium at 4.2 K. Efficiency of the cooling loop is around 0.20. Different geometries are tested and a part of observed physical phenomena are simulated with a numerical model. Interest of ferromagnetic cryogenic materials for the range 4-15 K is evidenced by measurement of thermomagnetic properties of europium sulfide.

32865 (KFK–4687) **Investigations on cooling by forced flow of helium II driven by fountain effect pumps.** Kraemer, H.P. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Technische Physik; Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Kernfusion; Karlsruhe Univ. (T.H.) (Germany, F.R.). Fakultaet fuer Physik. Feb 1990. 87p. (In German). Order Number DE90792466. Available from NTIS (US Sales Only), PC A05/MF A01.

The use of superfluid helium (He II) driven by a fountain effect pump as a forced flow coolant of a superconducting magnet is considered. The investigations cover the flow resistance of He II in porous plugs (superfilters) as well as in macroscopic ducts, the heat conductivity of He II, the calculation of the temperature profile in flowing He II and the heat transfer from technical copper to flowing He II. (orig./HP).

32866 (N–90-16013) **Demonstration of the feasibility of laser induced fluorescence for arc jet flow diagnostics.** Arepalli, S. Lockheed Engineering and Management Services Co., Inc., Houston, TX (USA). Oct 1989. 29p. (NASA-CR–185595;NAS–1.26:185595;LESC–27642;REPT–83-102). Available from NTIS, PC A03/MF A01.

Laser Induced Fluorescence (LIF) studies are carried out on nitric oxide and oxygen molecules in the arc jet flows at the NASA Johnson Space Center Reentry Testing Facility. Measurements are taken in the free stream and from a blunt body shock layer. Tests are performed under different flow conditions to determine the feasibility and sensitivity of the LIF technique for various species. This is developed as a part of high enthalpy flow diagnostics and will be useful to elucidate the rotational and vibrational temperatures. Adequate sensitivity for the detection of O(2) and NO is demonstrated. Proposed improvements of the existing system are presented.

32867 (PB–90-863465/XAB) **Heat exchangers: Biofouling. April 1974-January 1990 (A Bibliography from the COMPENDEX data base). Report for April 1974-January 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 76p. Available from NTISPC N01/MF N01.

Supersedes PB–89-867873.

This bibliography contains citations concerning biological fouling and associated corrosion of heat exchangers and cooling systems. Topics include chlorination methods and systems, biocides, microbiological corrosion control, and alternative controls that comply with environmental regulations. Applications in cooling towers, ocean thermal energy conversion, nuclear power plants, and conventional oil and coal fired power plants are considered. Antifouling coatings for marine applications are discussed in separate bibliographies. (This updated bibliography contains 159 citations, 68 of which are new entries to the previous edition.)

32868 (PIRSEM–2027.1) **Study of a liquid-vapour contact evaporator.** Pantaloni, J. Centre National de la Recherche Scientifique, 75 - Paris (France). Programme Interdisciplinaire de Recherche sur les Sciences pour l'Energie et les Matiernes Premieres (PRISEM); Aix-Marseille-1 Univ., 13 - Marseille (France). 1986. 178p. (In French). Order Number DE90790630. Available from NTIS (US Sales Only), PC A09/MF A01.

An experimental and theoretical study of the direct contact vapourization of the R 113 refrigerant (C2 F3 Cl3) and of the n-pentane (C5 H12) in a column of water (in counter-current flow) is presented. The effects of various values on the thermics and hydrodynamics of the exchange column are determined through a parametric analysis. The entrainment rate is derived and a dimensional optimization procedure is presented.

32869 (PNCT-N–9410-89-112) **FIDAS: a three-fluid subchannel code for dryout prediction in rod bundles.** Sakai, Takaaki (Power Reactor and Nuclear Fuel Development Corp., Oarai, Ibaraki (Japan). Oarai Engineering Center); Rummens, H.E.C.; Sugawara, Satoru. Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan). Jul 1989. 27p. Order Number DE90791140. Available from NTIS (US Sales Only), PC A03/MF A01.

A numerical code called FIDAS (film dryout analysis code in subchannels) has been developed with the main objective of simulating dryout and post-dryout heat transfer in rod bundles. This code features three-fluid representation of two-phase flow, in which the third fluid is liquid droplets entrained in the vapor phase. Since the code is able to predict the dryout occurrence by the film dryout criterion, no empirical CHF correlation is required. FIDAS gave good predictions of the onset of dryout when compared with experimental results from full-scale dryout tests on a 36-rod bundle. Furthermore, FIDAS gave better accuracy in predicting a wide range of thermalhydraulic conditions when compared with other subchannel codes. (author).

32870 (PNCT-N–9410-89-159) **Validation of film dryout model in a three-fluid code FIDAS.** Sugawara, Satoru (Power Reactor and Nuclear Fuel Development Corp., Oarai, Ibaraki (Japan). Oarai Engineering Center). Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan). Nov 1989. 52p. Order Number DE90791141. Available from NTIS (US Sales Only), PC A04/MF A01.

Analytical prediction model of critical heat flux (CHF) has been developed on the basis of film dryout criterion due to droplets deposition and entrainment in annular mist flow. CHF in round tubes were analyzed by the Film Dryout Analysis Code in Subchannels, FIDAS, which is based on the three-fluid, three-field and newly developed film dryout model. Predictions by FIDAS were compared with the world-wide experimental data on CHF obtained in water and Freon for uniformly and non-uniformly heated tubes under vertical upward flow condition. Furthermore, CHF prediction capability of FIDAS was compared with those of other film dryout models for annular flow and Katto's CHF correlation. The predictions of FIDAS are in sufficient agreement with the experimental CHF data, and indicate better agreement than the other film dryout models and empirical correlation of Katto. (author).

32871 (SAND–90-0230C) **The effect of charge mixture ratio and particle size on igniter plume heat transfer characteristics.** Evans, N.A.; Brezowski, C.F. Sandia National Labs., Albuquerque, NM (USA). [1990]. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900792–3: 15. international pyrotechnics seminar, Boulder, CO (USA), 9-13 Jul 1990). Order Number DE90010833. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Investigation of the heat transfer characteristics of igniter output plumes, first reported at the Fourteenth International Pyrotechnics Seminar in 1989, has continued, using two types of igniter to determine the effect of charge mixture ratio and fuel particle size on performance. While both of these igniters had the same metallic closure disc (scored Hastelloy with a capture cone), the bridgewire sensitizer (or ignition mixture) was barium styphnate for one type, and a particular blend of fine particle titanium/potassium perchlorate ("PB") for the other type. The output mixture for both types was titanium/potassium perchlorate; two mixture ratios (33/67 and 41/59), and two titanium particle sizes (2 and 8 μm) were used. The results show that, for both types of igniter, the coarse particle size titanium produced the best performance. The overall best performance was obtained from the igniter using the "PB" ignition mixture and an output charge of 41/59 titanium/potassium perchlorate. 2 refs., 6 figs., 1 tab.

32872 **Drop oscillations in liquid-liquid systems.** Basaran, O.A. (Chemical Technology, Div., Oak Ridge National Lab., Oak Ridge, TN (US)); Scott, T.C.; Byers, C.H. *A.I.Ch.E. Journal (American Institute of Chemical Engineers) (USA),* 35(8): 1263-1270 (Aug 1988). DOE Contract AC05-84OR21400.

When the ratio of the drop radius to the distance separating any two drops and the relative importance of gravitational to surface forces are both small, the small amplitude oscillations of a drop of one viscous fluid immersed in another fluid are governed by the nonlinear dispersion relation derived by Miller and Scriven. The dispersion relation has been solved numerically to determine the character of oscillations for arbitrary values of drop size, physical properties of the two fluids, and interfacial tension. The new theoretical results determine the range of validity of the low-viscosity approximation, and are also shown to be essential for proper interpretation of many previously reported experimental results. New experimental measurements of natural frequencies of oscillation of water drops falling in 2-ethyl-1-hexanol, a system having properties characteristic of many others in solvent extraction, agree well with the theoretical predictions when drop radius is smaller than a critical size.

4205 Materials Testing

Refer also to citation(s) 32337, 32374, 32629, 33007

32873 (SAND–90-0506C) **A comparison of CTH predictions with experimental armor/anti-armor data for long rod penetrators in two and three dimensions.** Hertel, E.S.; McGlaun, J.M.; Yarrington, P. Sandia National Labs., Albuquerque, NM (USA). May 1990. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9005122–3: 1990 conference on the application of 3-D hydrocodes to armor/anti-armor problems, Aberdeen Proving Ground, MD (USA), 7-11 May 1990). Order Number DE90009744. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

CTH is a software system under development at Sandia National Laboratories (SNL) to model multidimensional, multi-material, large deformation, strong shock wave physics. One-dimensional rectilinear, cylindrical, and spherical meshes; two-dimensional rectangular, and cylindrical meshes; and three-dimensional rectangular meshes are currently available. A two-step Eulerian solution scheme is used with these meshes. The first step is a Lagrangian step in which the cells distort to follow the material motion. The second step is a remesh step where the distorted cells are mapped back to the original Eulerian mesh. CTH has several thermodynamic models that are used for simulating strong shock, large deformation events. Both tabular and analytic equations of state are available. CTH can model material strength, high explosive detonation, fracture, and motion of fragments smaller than a computational cell. The material strength model is elastic perfectly plastic with thermal softening. A

programmed burn model is available for computing the thermodynamic properties of explosive detonation. The Jones-Wilkins-Lee equation of state is available for modelling high explosive reaction products. Fracture can be initiated based on pressure or principle stress. A special model is available for moving fragments smaller than a computational cell with the correct statistical velocity. 7 refs.

32874 Holographic measurement of ejecta from shocked metal surfaces. McMillan, C. (Lawrence Livermore National Lab., Livermore, CA (US)); Whipkey, R. 553-558 of Proceedings of the 18th international congress on high speed photography and photonics. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). DOE Contract W-7405-ENG-48. (CONF-8808103--: 18. international congress on high-speed photography and photonics, Xian (China), 28 Aug - 2 sep 1988).

The authors describe a holographic system that measures the size distribution of particles ejected from a shocked lead surface at speeds up to 2.8 mm/μ. Observed diameters range from 3 μ to 5 μ. The three-dimensional distribution of the particles permits inferences about the uniformity of their distribution and velocity. Comparison of the holographic results for the mass with those obtained using a momentum transfer technique show general agreement but indicate that further refinement of both techniques may be necessary.

4210 Combustion Systems

Refer also to citation(s) 32120, 32316, 32837, 33097, 33098

32875 (PB--90-863424/XAB) **Fluidized bed combustion: Mechanical systems and chemical processes. December 1973-March 1990 (A Bibliography from the NTIS data base). Report for December 1973-March 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 165p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning research and development activities of mechanical systems and chemical processes pertaining to fluidized-bed combustion systems. Descriptions and evaluations of the following topics are considered: combustion and ignition studies, mechanical elements, heating and cooling systems, industrial chemistry, and chemical-process engineering. (Contains 286 citations fully indexed and including a title list.)

4220 Mining and Underground Engineering

32876 Node-based network analysis and its application to mine ventilation. Gregory, W.S. (Los Alamos National Laboratory, NM (USA)); Nichols, B.D.; Idzorek, R. 583-588 of Proceedings of the 3rd mine ventilation symposium. Mutmansky, J.M. (ed.). Society of Mining Engineers, Inc., Littleton, CO (US) (1987). (CONF-8710102--: 3. U.S. mine ventilation symposium, University Park, PA (USA), 12-14 Oct 1987).

A numerical procedure to model flow networks using a node-based approach is discussed, and the analysis encompasses both steady-state and transient solutions. A family of computer codes has been developed using the node-based approach. This technique is illustrated by applying two of the computer codes to mine ventilation networks.

32877 Three-dimensional computer modeling of particulate flow around dust monitors. Nichols, B.D. (Los Alamos National Laboratory, NM (USA)); Gregory, W.S. 595-602 of Proceedings of the 3rd mine ventilation symposium. Mutmansky, J.M. (ed.). Society of Mining Engineers, Inc., Littleton, CO (US) (1987). (CONF-8710102--: 3. U.S. mine ventilation symposium, University Park, PA (USA), 12-14 Oct 1987).

SOLA-DM is a three-dimensional finite-difference computer code designed to model the dynamics of an incompressible fluid and the transport of discrete particulate material around obstacles impervious to flow. The numerical methods used in this code are described. SOLA-DM was used to predict the particle flux sampled by the 10-mm Dorr-Oliver Cyclone and MINIRAM dust monitors. Various geometric and dynamic variations of monitor and airflow combinations were tested. The code predictions are shown in computer-generated graphic plots.

4250 Power Cycles

Refer also to citation(s) 32499

4260 Components, Electron Devices and Circuits

Refer also to citation(s) 32284, 32499, 32537, 32557, 32616, 32661, 32665, 32711, 32714, 32860, 32862, 32930, 32977, 32979, 32986, 32989, 32997, 33017, 33025, 33038, 33042, 33043, 33345, 33788, 33790, 33824, 33827, 33828

32878 (ANL--89/35) **Practical superconductor development for electrical power applications: Annual report for FY 1989.** Goretta, K.C. (comp.). Argonne National Lab., IL (USA). Sep 1989. 76p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. Order Number DE90010262. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Development of useful high-critical-temperature (high-T_c) superconductors requires the synthesis of various superconducting oxide compounds; the fabrication of wires, tapes, and thin films from these compounds; the capability to form composite structures that incorporate integral insulators of stabilizers; and the design of efficient components and systems. This report describes the technical progress in and status of research efforts aimed at producing superconducting components based on the oxide systems YBCO, BSCCO, and TCBCO. Topics discussed are synthesis and heat treatment of high-$T_c$superconductors; formation of monolithic and composite wires and tapes; design and fabrication of superconductor/metal connections; characterization of microstructures and of superconducting, electrical, and mechanical properties; and fabrication and electrical properties of thin films. Interactions with industry and academia are also documented, and a list of selected program publications is provided. 139 refs., 32 figs., 1 tab.

32879 (CTA-IEAv-NT--004/89) **Determination of calibration constants for perturbing objects of cavity resonators.** Franco, M.A.R.; Serrao, V.A.; Fuhrmann, C. Centro Tecnico Aeroespacial, Sao Jose dos Campos, SP (Brazil). Inst. de Estudos Avancados. May 1989. 18p. (In Portuguese). Order Number DE90626993. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Using the Slater theorem, the calibrating constants for objects utilized in the tecnique of perturbing measurements of cavities electric and magnetic fields have been determined. Such perturbing objects are utilized in the measurements of the shunt impedance and electric field relative intensity ocurring in linac accelerating structures. To determine the calibrating constants of the perturbing objects, a cylindrical cavity of well know field pattern has been utilized. The cavity was excited in two differente modes of oscillation and the experimental results are in good aggrement with the theoretical values. (author).

32880 (EGG--2591) **Cast coil transformer fire susceptibility and reliability study.** McBride, S.A. EG and G Idaho, Inc., Idaho Falls, ID (USA). Feb 1990. 76p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90010234. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This report investigates the fire characteristics and reliability of cast coil type transformers. A literature search was conducted and a questionnaire drafted requesting information from the manufacturers of cast coil type transformers. Abstracts from the National Fire Protection Association were reviewed to locate possible fires involving cast coil transformers. Testing was performed by the Idaho National Engineering Laboratory and independent testing firms. Results of this research and general industry usage indicate that cast coil transformers reduce risk to the user compared to liquid-filled units, eliminate environmental impacts, are more efficient than most transformer designs, and add minimal risk to the facility in a fire situation. Cast coil transformers have a long record of operation and have to be reliable and efficient. 32 refs., 2 figs., 8 tabs.

32881 (SAND--90-0368C) **Statistical process control for QML [Qualified Manufacturer's List] radiation hardness assurance.** Winokur, P.S.; Sexton, F.W.; Fleetwood, D.M.; Schwank, J.R.; Shaneyfelt, M.R.; Terry, M.D. Sandia National Labs., Albuquerque, NM (USA). [1990]. 4p. Sponsored by U.S. DOE Defense

Programs. DOE Contract AC04-76DP00789. (CONF-900723–5: 27. IEEE annual international nuclear and space radiation effects conference, Reno, NV (USA), 16-20 Jul 1990). Order Number DE90007413. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Effective testing of highly-complex VLSI circuits employing ever decreasing feature sizes is becoming extremely difficult. This difficulty arises from the inability to routinely provide 100% fault coverage during testing of these complex functions, as well as by a scarcity of functional parts inherent in low-volume/high-product-mix military-component manufacturing lines. Under the sponsorship of RADC and DESC, the government has proposed a Qualified Manufacturer's List (QML) methodology to qualify ICs for high reliability and radiation hardness. In this approach, a production line is certified on a "one-time" basis, and all product from that line is subsequently qualified per the requirements of MIL-STD-38535. The approach places a large burden on the manufacturer or production source, who is tasked with demonstrating that the quality of the part is "built in," as opposed to being "tested in." This "built-in" quality is assured by the proper control of the IC manufacturing sequence from design through assembly. 13 refs., 5 figs.

32882 (SAND–90-0436C) **Field dependence of interface trap buildup in Si-gate MOS devices.** Shaneyfelt, M.R. (Allied-Signal, Inc., Albuquerque, NM (USA). Microelectronics Operation); Schwank, J.R.; Fleetwood, D.M.; Winokur, P.S.; Sexton, F.W. Sandia National Labs., Albuquerque, NM (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900723–10: 27. IEEE annual international nuclear and space radiation effects conference, Reno, NV (USA), 16-20 Jul 1990). Order Number DE90007679. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Radiation-induced interface traps in Si-gate MOS devices follow an $E^{-1/2}$ electric field dependence for $E \geq +0.13$ MV/cm when electron-hole recombination effects are included. A hybrid model involving hole trapping and hydrogen transport is suggested. 20 refs., 4 figs.

32883 (SAND–90-1209C) **An algorithm for using a slide-screw tuner as a computer-controlled impedance.** Sloan, G. Sandia National Labs., Albuquerque, NM (USA). [1990]. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9005175–1: Automatic RF Technology Group (ARFTG) conference, Dallas, TX (USA), 10-11 May 1990). Order Number DE90010657. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In the testing of active microwave components, a common test procedure is to evaluate a device's performance when subjected to an all-phase, constant-standing-wave-ratio (APCS) load pull. Such a test specification is useful in verifying a device's stability and mismatch performance. Typically, APCS pulls are tediously performed by hand, with manually operated tuners. However, with the advent of mechanical, computer-controlled tuners, it is how possible to automate this procedure. At Sandia, the goal was to integrate an APCS pull capability into a multi-test, single-connection tester. (The single-connection concept implies that many test, such as network analysis, spectral analysis, and noise figure measurements can be made from a one-time, device-to-tester connection). Consequently, the slide-screw tuner was the obvious choice due to its removable probe capability. Hence, it became necessary to develop a custom algorithm capable of utilizing the tuner in an impedance-finding mode. The general concept used in implementing this capability was to empirically characterize the tuner over and acceptable range of tuner positions, and then use this characterization to intelligently predict the tuner positions needed to present the desired impedance. 4 figs.

32884 (UCRL–102201) **Development of a large scale Nd:YAG growth process.** O'Dell, E.W. (Allied-Signal, Inc., Morristown, NJ (USA)); Nelson, D.J.; Narasimhan, D.; Morris, R.C.; Marion, J.E. Lawrence Livermore National Lab., CA (USA). Jan 1990. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900140–25: SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition, Los Angeles, CA (USA), 15-19 Jan 1990). Order Number DE90010746. Available from NTIS, PC A03/MF A01 - OSTI.

Development of an automated steady-state process for Czochralski growth of flat interface Nd:YAG laser crystals is described. Steady-state is achieved through addition to the melt to maintain constant melt depth and composition. Interface flattening is accomplished through a controlled spin-up of crystal rotation during which characteristic changes in melt flow and crystal weight are observed. Combined steady-state/flat-interface growth has been demonstrated for sections up to 30 mm diameter x 110 mm long. In batch mode, without melt addition, flat interface YAG and Nd:YAG up to 52 mm x 220 mm, and undoped YAG up to 85 mm x 75 mm have been grown. In batch mode, gradual reduction of rotation rate is required to maintain interface contour and cross-sectional shape of the crystal as the melt height decreases. 17 refs., 5 figs.

32885 (UCRL–102667) **KD*P frequency doubler for high average power applications.** Norton, M.; Eimerl, D.; Ebbers, C.; Velsko, S.; Petty, C. Lawrence Livermore National Lab., CA (USA). 12 Jan 1990. 8p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900140–26: SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition, Los Angeles, CA (USA), 15-19 Jan 1990). Order Number DE90010747. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We describe here the development and operation of a kilowatt scale KD*P second harmonic generator. The design utilizes a simple and compact two-plate alternating-Z configuration with a transverse thermal gradient. The calculated single pulse conversion efficiency is between 50 and 75% for beams whose divergence is up to 15 times the diffraction limit. Offline subaperture tests demonstrated that the effect of induced thermal gradients on conversion efficiency was less than 5% for optical loads expected for kilowatt operation. Full aperture tests with a 300 watt average power Nd:glass zig-zag slab laser gave conversions of 35%. 4 refs., 10 figs.

32886 (UCRL-CR–103860) **System coupling and effects optimization.** Lee, K.S.H.; Yang, F.C.; Wong, F. Kaman Sciences Corp., Santa Monica, CA (USA). Dikewood Div. Dec 1989. 33p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (DC-FR–9000-1). Order Number DE90010757. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In this report some approaches have been suggested for dealing with the system coupling problem through their back doors. One approach is to synthesize the whole solution form the its parts, which can be approximately calculated individually–the so-called decomposition approach. The critical parameter in this approach is the Q-factor of the loaded cavity, the approach to determining which is yet to be found. The concepts of zeros and poles has also been put forward to simplify the picture of system back-door coupling, especially for sources with a few frequency parameters, such as carrier frequency, bandwidth and modulation frequency. The parameters in this approach are the poles and residues. One may be able to guess the locations of a few important poles. The residues, on the other hand, are difficult to estimate. Perhaps a statistical and empirical treatment is needed. The problem of effects optimization has been formulated in terms of minimizing the on-target fluence (or power density) required for a probability of effects equal to or greater than a prescribed value. The approach depends critically on the output of the assessment of the target of interest. 7 refs., 15 figs., 1 tab.

32887 (UCRL-JC–103302) **Modeling pulse driven antenna systems with finite differences.** Barth, M.; Pennock, S.; Ziolkowski, R.; McLeod, R. Lawrence Livermore National Lab., CA (USA). Mar 1990. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9003128–3: 6. annual review of progress in applied computational electromagnetics, Monterey, CA (USA), 20-22 Mar 1990). Order Number DE90010682. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We have developed a capability of modeling the performance of general, pulse driven, antenna systems. Our approach is to use TSAR, a three dimensional finite difference time domain (FDTD) code, to model the antenna structure and the surrounding near field environment. We then use a far field projection algorithm to

obtain its far field response. Specifically, this algorithm utilizes the tangential electric and magnetic fields at a specified surface of the TSAR FDTD computational volume and calculates the resulting fields far from the equivalent magnetic and electric sources. This approach will be illustrated by considering the TEB antenna system. The system is modeled with the code and the results are compared with anechoic chamber data. 10 figs., 2 tabs.

32888 **Measurement of ground state copper density using hook spectroscopy.** Molander, W.A. (Lawrence Livermore National Lab., Livermore, CA (US)). 11-18 of Metal vapor, deep blue, and ultraviolet lasers. Kim, J.J.; Kimball, R.; Wisoff, P.J. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-890166–: Conference on metal vapor, deep blue, and ultraviolet lasers technology and applications, Los Angeles, CA (USA), 17-20 Jan 1989).

This paper reports the density of ground state copper atoms measured in an operating large-bore copper laser using hook spectroscopy. In this method, dispersion, due to the copper resonance lines at 327.4 nm and 324.7 nm, is measured by placing the copper laser tube in one arm of a March-Zehnder interferometer illuminated by a broad bandwidth UV source. The light source was a Nd:YAG-laser-pumped dye laser which was modified to have a 15 nm bandwidth and then frequency doubled in a 3 mm thick KDP crystal, resulting in a UV beam with an 8 nm bandwidth. The Nd:YAG laser was synchronized with the copper laser, allowing a time resolution of 8 ns. Copper density was measured both as a function of time and as a function of radial position across the bore of the tube. The radial resolution was about 2 mm. The space-dependent data gives information about the gas temperature distribution since the density is inversely proportional to the temperature. The gas temperature distribution found in this way agrees well with the predictions of a simple heat-conduction model which assumes uniform power deposition. The power deposition found in this way is compared to that found by calorimetry.

32889 **Preionization techniques for discharge lasers.** Tallman, C. (Laser Sciences and Applications, Los Alamos National Lab., Los Alamos, NM (US)). 2-14 of Pulse power for lasers II. Burkes, T.R.; McDuff, G. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). (CONF-8901155–: 2. pulse power for lasers, Los Angeles, CA (USA), 19-20 Jan 1989).

The author discusses how the success of discharge-pumped laser depends upon achieving some degree of control over the discharge stability. A very large effort has been expended toward this goal by researchers since the early discharge CO_2 lasers were developed. With the extensive development of the rare gas halide lasers much more effort has been expended because of the inherent instability in pumping electronegative gases.

32890 **X-ray preionization technology for high pressure gas discharge lasers.** Shields, H. (Jamar Technology Co., Ste. D., San Diego, CA (US)). 15-23 of Pulse power for lasers II. Burkes, T.R.; McDuff, G. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). (CONF-8901155–: 2. pulse power for lasers, Los Angeles, CA (USA), 19-20 Jan 1989).

The physical processes involved in x-ray preionization of high-pressure avalanche-discharge gas lasers are reviewed to determine optimum preionizer parameters. Preionization of lasers such as XeCl, CO_2 etc., requires an x-ray dose of ~1mR. More strongly attaching rare-gas-flouride lasers (e.g. KrF) require stronger preionization (>10 mR per pulse). X-ray generation by electron-beam sources is discussed and candidate cathode types are reviewed. Typical preionizer pulsed-power parameters are 100 kV pulses of 100-200 ns duration, electron-beam current density of 1A cm^{-2} and repetition rate of ~100 pps.

32891 **Excitation of pulsed flashlamps with a linear response high power amplifier.** Graham, G. (Texas Tech Univ., Lubbock, TX (USA). Dept. of Electrical Engineering); Portnoy, W.; Martin, C.; Sorem, M. 28-34 of Pulse power for lasers II. Burkes, T.R.; McDuff, G. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). (CONF-8901155–: 2. pulse power for lasers, Los Angeles, CA (USA), 19-20 Jan 1989).

Classically, pulsed flashlamps have been driven (excited electrically) with a single loop RLC critically damped circuit. The capacitor is chosen for the required energy output, the inductor tunes the peak current for optical output requirements, and the resistor is used to ensure that the circuit is critically damped (that is no current reversal that can extinguish the lamp). A few circuits using several discharge loops, known as a pulse forming network, or PFN, have been explored but again, the current in the lamp is controlled by the passive circuit components. With both circuits, a two state closing switch, such as an SCR, is used to initiate current flow. This approach severally limits the agility in changing the drive characteristics as it is a point design. To make such a change, the entire discharge circuit must be redesigned. This paper reports on a new excitation circuit. It utilizes the active region of high power field effect transistors in a Class A or Class AB amplifier circuit to provide a linear control of the flashlamp current. Having linear control will eliminate the need for simmer circuits required when a two state closing switch is used, (the simmer circuit keeps the flashlamp ionized in the interpulse period). Also, since the optical output of the flashlamp is dependent on the lamp current, the spectral output can be adjusted to enhance wanted frequencies and depress unwanted wavelengths which will lead to greater efficiency which is not the case in a single point design circuit.

32892 **Elastic constants of two $Y_1Ba_2Cu_3O_x$ superconductors: x = 6.70 and 6.92.** Ledbetter, H.M. (Fracture and Deformation Div., Institute for Materials Science and Engineering, National Bureau of Standards, Boulder, CO (US)); Kim, S.A.; Lei, M.; Capone, D.W. 17-24 of Cryogenic materials '88. Reed, R.P.; Zing, Z.S.; Collings, E.W. International Cryogenics Materials Conference (ICMC), Boulder, CO (USA) (1988). (CONF-880653–: International conference on cryogenic materials: applications and properties, Shenyang (China), 7-10 Jun 1988).

The authors measured between 295 and 4 K the elastic constants of polycrystalline $Y_1Ba_2Cu_3O_x$ with two oxygen contents:x = 6.70 and x = 6.92. The two sets of ambient-temperature elastic stiffnesses - Young, shear, bulk, longitudinal moduli - agree within two percent. Derived Debye temperatures, 345 and 350 K, agree closely with the thermal-expansion Debye temperature, 370 K, but disagree with the specific-heat Debye temperature, 440 K. The Poisson ratio, 0.200, falls slightly below that of $BaTiO_3$ (0.222) and $SrTiO_3$ (0.232). Perhaps, this represents a texture artifact. Upon cooling to 4 K, the specimens showed similar, but distinct, behavior. The high-oxygen specimen showed a larger elastic-stiffness increase. Both specimens showed strong (150-200 K) thermal hysteresis. Within measurement error (1 part in 1000), neither specimen showed an elastic-constant discontinuity at the normal-superconductive phase transition.

32893 **Engineering aspects of long pulse, CO_2 lasers employing plasma discharge electrodes.** Peter, R.A. (W.J. Schafer Associates, Inc., Chelmsford, MA (US)); Yoder, M.J.; Schaefer, R.B. 113-120 of Pulse power for lasers II. Burkes, T.R.; McDuff, G. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). (CONF-8901155–: 2. pulse power for lasers, Los Angeles, CA (USA), 19-20 Jan 1989).

The authors report on an experimental long pulse CO_2 laser (25uS at 10 ω) that employed two plasma electrodes and an impedance-matched external sustainer pulser to preionize and electrically pump the CO_2 laser mixture. The plasma electrodes, each measuring 7cm wide by 100cm long, were struck on by a 10^{11} V/S voltage trigger wavefront, and were found to have a uniform arc distribution along the electrodes in argon, but showed severe arc striations in CO_2 mixtures. These striations resulted in non-uniform laser preionization, which in turn caused the sustainer discharge to constrict. Consequently the active laser volume was not pumped uniformly and the system did not lase. However, the CO_2 discharge did not collapse into a low-impedance arc at energy loading greater than 350 J/1-atm and 25uS pulse duration, indicating that by improving the arc uniformity on the plasma electrodes, this approach can be useful for high energy, long pulse lasers. Finally, important engineering issues like system life, and size and weight scaling for the plasma electrode CO_2 laser are discussed.

32894 **Review of long-pulse laser development.** Sze, R.C. (Los Alamos National Lab., Los Alamos, NM (US)). 176-185 of Metal vapor, deep blue, and ultraviolet lasers. Kim, J.J.; Kimball,

R.; Wisoff, P.J. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). (CONF-890166–: Conference on metal vapor, deep blue, and ultraviolet lasers technology and applications, Los Angeles, CA (USA), 17-20 Jan 1989).

A brief review of some present techniques to obtain long-pulse laser action in excimer discharge devices is presented. An attempt is made to point out the strengths and weaknesses of these techniques.

32895 Bipolar transistor fabrication using gas immersion laser doping. Weiner, K.H. (Lawrence Livermore National Lab., Livermore, CA (US)); Sigmon, T.W. 214-218 of Metal vapor, deep blue, and ultraviolet lasers. Kim, J.J.; Kimball, R.; Wisoff, P.J. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). (CONF-890166–: Conference on metal vapor, deep blue, and ultraviolet lasers technology and applications, Los Angeles, CA (USA), 17-20 Jan 1989).

Gas immersion laser doping (GILD) is presented as a powerful process to fabricate emitter and base regions in narrow-base bipolar transistors. Characterization of maximum melt depth versus silicon surface melt time is performed. Results of this characterization demonstrate that surface melttime provides an accurate in-situ measurement of junction depth. The GILD process is then used to fabricate the emitter and active-base regions in simple bipolar transistors. Base widths ranging from 700 Å to 1200 Å are achieved. The transistors exhibit good electrical behavior with maximum forward current gains greater than 50.

32896 Radiation induced amorphization in $YBa_2Cu_3O_7$ and $GdBa_2Cu_3O_7$ superconductors. Parkins, D.M. (Los Alamos National Lab., NM (USA). Materials Science and Technology Div.); Nastasi, M. 351-356 of Processing and characterization of materials using ion beams. Rehn, L.E.; Greene, J.; Smidt, F.A. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811225–: Processing and characterization of materials using ion beams, Boston, MA (USA), 28 Nov - 2 dec 1988).

The response of $YBa_2Cu_3O_7$ and $GdBa_2Cu_3O_7$ high temperature superconductors to particle irradiation is examined. Both ion and electron irradiations have been shown to first produce an orthorhombic-to-tetragonal transformation at relatively low doses followed by a tetragonal-to-amorphous transformation at doses roughly a factor of 10 higher. Analysis of the displacement stoichiometry that results from 120, 300, and 1000 keV elecron irradiations, 400, and 500 keV O irradiations, and 300 keV helium irradiations indicate that the orthorhombic-to-tetragonal transformation is driven by O atom displacements either alone or in the presence of metal atom displacements and that the transformation to the amorphous phase is driven by displacements on the Y, Gd or other rare earth atom site.

32897 Fabrication of Rutherford-type superconducting cables for construction of dipole magnets. Scanlan, R.M. (Lawrence Berkeley Lab., CA (USA)); Royet, J.; Hannaford, R. 391-400 of Cryogenic materials '88. Reed, R.P.; Zing, Z.S.; Collings, E.W. International Cryogenics Materials Conference (ICMC), Boulder, CO (USA) (1988). (CONF-880653–: International conference on cryogenic materials: applications and properties, Shenyang (China), 7-10 Jun 1988).

An experimental cabling machine has been constructed and used to investigate the fabrication of a variety of superconducting cables. These include the 23- strand and 30-strand NbTi alloy cables for the Superconducting Supercollider (SSC) and a number of experimental cables. The experimental cables include 24- strands and 36-strands as well as two-level cables with a 6 or 7-strand first level and 23 or 30-strand second level. These results were used to aid in selecting the optimum cable for the SSC dipole and quadrupole magnets. As a result of these studies, cable can now be fabricated to exacting mechanical tolerances (±.006 mm) and with low critical current degradation (2-5%). In addition, tooling design studies have been performed and a Prototype SSC Production Cabling Machine has been designed. The results of the cable optimization studies and the tooling design studies are discussed. SSC cable production experience on the experimental cabling machine and the production cabling machine is reported.

32898 Processing chemically prepared $YBa_2Cu_3O_7$ precursor powders. Voigt, J.A. (Sandia National Lab., Albuquerque, NM (US)); Bunker, B.C.; Lamppa, D.L.; Harrington, M.S. 303-309 of Rare earths: Extraction preparation and applications. Bautista, R.G.; Wong, M.M. The Metallurgical Society Inc., Warrendale, PA (USA) (1988). DOE Contract AC04-76DP00789. (CONF-890251–: Rare earth conference: extraction preparation and applications meeting, Las Vegas, NV (USA), 27 Feb - 2 mar 1989).

In an effort to determine the optimum conditions for preparing high purity, fine particle size high temperature superconducting oxide powder the authors have investigated how calcination conditions influence the conversion of a chemically prepared hydroxycarbonate precursor powder to $YBa_2Cu_3O_7$. The authors find that the precursor can be converted to phase pure $YBa_2Cu_3O_7$ in either oxygen or synthetic air (20% O_2, 80% N_2) at 850°C. This temperature is substantially lower than the temperature (>900°C) normally used for the calcination of mixed-oxide powders. The lower calcination temperature prevents particle sintering and maintains the desired fine particle size. Powder processed in synthetic air shows a low degree of crystallinity indicating it may be more sinterable than the highly crystalline powders produced when an oxygen atmosphere is used. Intimate contact between powder particle surfaces and a flowing gas atmosphere promotes the reaction between the $BaCO_3$ component of the precursor powder and the Y and Cu constituents.

32899 Effects of shock-induced defects on flux pinning in $YBa_2Cu_3O_{7-\delta}$. Weir, S.T. (Lawrence Livermore National Lab., Univ. of California, Livermore, CA (US)); Nellis, W.J.; Early, E.A.; Seaman, C.L.; Maple, M.B. 1263-1264 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

A composite specimen of $YBa_2Cu_3O_{7-\delta}$ and silver was fabricated by shock-compacting to 167 kbar a mixture of $YBa_2Cu_3O_{7-\delta}$ and silver powders. The magnetic flux pinning energy of this specimen was then measured as a function of temperature using flux relaxation data obtained with a SQUID magnetometer. Results show that the pinning energy of the shock-compacted sample is significantly higher than the pinning energy of the $YBa_2Cu_3O_{7-\delta}$ before compaction. The increase in flux pinning energy is presumably due to the introduction of shock-induced defects into the $YBa_2Cu_3O_{7-\delta}$.. This result is significant because higher pinning energies imply higher intragranular critical currents.

32900 Surface resistance of $YBa_2Cu_3O_7$ films deposited on $LaGaO_3$ substrates. Cooke, D.W.; Gray, E.R.; Houlton, R.J.; Javadi, H.H.S.; Maez, M.A.; Bennett, B.L.; Rusnak, B.; Meyer, E.A.; Arendt, P.N.; Beery, J.G. 1537-1538 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Superconducting films of $YBa_2Cu_3O_7$ deposited onto $LaGaO_3$ substrates were prepared by e-beam and magnetron sputtering techniques. Surface resistance measurements made at 22 GHz, 86 GHz, and 148 GHz show that these films are superior to those deposited by similar techniques onto $SrTiO_3$. Typical surface resistance values measured at 22 GHz and 12 K are ~2 m(cgom) with the lowest value being 0.2 m(cgom), which is only 2 to 4 times higher than Nb. The surface resistance is proportional to the square of the measuring frequency.

32901 S-N-S behavior of grain boundaries in polycrystalline $La_{1.85}Sr_{0.15}CuO_{4-y}$. Roshko, A. (National Institute of Standards and Technology, Boulder, CO (US)); Moodera, J.S.; Chiang, Y.-M. 1625-1626 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA)

(1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

This paper reports an investigation of the field and temperature dependence of transport J_c in well characterized, polycrystalline $La_{1.90:0085}Sr_{0.15}CuO_{4-y}$. The behavior at low fields, close to T_c corresponds to that of *S-N-S* junctions.

32902 Soft x-ray lasers. Matthews, D.L.; Rosen, M.D. *Scientific American (USA)*, 259(6): 86-91 (Dec 1988).

One of the elusive dreams of laser physicists has been the development of an x-ray laser. After 25 years of waiting, the x-ray laser has at last entered the scientific scene, although those now in operation are still laboratory prototypes. They produce soft x rays down to about five nanometers. X-ray lasers retain the usual characteristics of their optical counterparts: a very tight beam, spatial and temporal coherence, and extreme brightness. Present x-ray lasers are nearly 100 times brighter that the next most powerful x-ray source in the world: the electron synchrotron. Although Lawrence Livermore National Laboratory (LLNL) is widely known for its hard-x-ray laser program which has potential applications in the Strategic Defense Initiative, the soft x-ray lasers have no direct military applications. These lasers, and the scientific tools that result from their development, may one day have a place in the design and diagnosis of both laser fusion and hard x-ray lasers. The soft x-ray lasers now in operation at the LLNL have shown great promise but are still in the primitive state. Once x-ray lasers become reliable, efficient, and economical, they will have several important applications. Chief among them might be the creation of holograms of microscopic biological structures too small to be investigated with visible light. 5 figs.

32903 Low cost active–active oscillator utilizing loss feedback control. Smith, D.L. (Hampshire Instruments Inc., 10 Carlson Rd., Rochester, NY 14610 (USA)); Kelly, J.H.; Shoup, M.J. III. *Applied Optics (USA)*, 29(6): 786-790 (20 Feb 1990). DOE Contract FC03-85DP40200.

We have constructed a low-cost, phosphate glass actively mode-locked, actively Q-switched oscillator that produces pulses from 150 to 1000 ps with high energy. This was accomplished by reducing the time required for relaxation oscillations to die out through the use of an acoustooptic feedback system. We describe system performance and construction details of this oscillator.

32904 Eigenmode analysis of optical guiding in free-electron lasers. Xie, M. (Accelerator Research Division, Lawrence Berkeley Laboratory. Berkeley, California 94720 (USA)); Deacon, D.A.G.; Madey, J.M.J. *Physical Review, A (General Physics) (USA)*, 41(3): 1662-1669 (1 Feb 1990).

The spatial properties of the optical field and hence the performance of a free-electron laser depend on the fact that the electron beam, which acts as both an amplifying and a refractive medium, is transversely nonuniform. Under certain circumstances, optical guiding may be realized, where the optical field is stably confined near the electron beam and amplified along the beam over many Rayleigh ranges. We show that the three-dimensional evolution of the optical field through the interaction region can be determined by a guided mode expansion before saturation. Optical guiding occurs when the fundamental growing mode becomes dominant. The guided mode expansion is made possible by implementing the biorthogonality of the eigenmodes of the coupled electron-beam optical-wave system. The eigenmodes are found to be of vectorial form with three components; one specifies the guided optical mode and the other two describe the density and the energy modulations of the electron beam.

32905 X-ray laser with enhanced x-ray gain through photodepopulation. Elton, R.C. To Department of the Navy, Washington, DC. USA Patent Application 7-414,499. 29 Sep 1989. 15p. Available from NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

The present invention relates to x-ray lasers employing hydrogenic lasing ions of nuclear charge Z, for n=2 to 4 or 6 excitation, and radiating ions of nuclear charge Z/2 for decreasing the n=2 population density of the hydrogenic lasing ions of nuclear charge Z. It is an object of the invention to increase the population inversion and gain to saturation, to improve the overall efficiency, and to increase the plasma size by decreasing the population density N2.

43 PARTICLE ACCELERATORS

4301 Design, Development, and Operation

Refer also to citation(s) 33812

32906 (BNL–44466) **New challenges for HEP computing: RHIC [Relativistic Heavy Ion Collider] and CEBAF [Continuous Electron Beam Accelerator Facility].** LeVine, M.J. (Brookhaven National Lab., Upton, NY (USA)). Brookhaven National Lab., Upton, NY (USA). [1990]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-9004190–1: Computing in high energy physics, Santa Fe, NM (USA), 9-13 Apr 1990). Order Number DE90010641. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We will look at two facilities; RHIC and CEBF. CEBF is in the construction phase, RHIC is about to begin construction. For each of them, we examine the kinds of physics measurements that motivated their construction, and the implications of these experiments for computing. Emphasis will be on on-line requirements, driven by the data rates produced by these experiments.

32907 (BNL–44606) **Relativistic heavy ions from the BNL [Brookhaven National Laboratory] booster medical research and technological applications.** Thieberger, P. Brookhaven National Lab., Upton, NY (USA). May 1990. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. Order Number DE90011122. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The BNL Booster, now nearing completion, was designed to inject protons and heavy ions into the Alternating Gradient Synchrotron (AGS) for further acceleration. In the future, ion beams from the AGS will in turn be further accelerated in the Relativistic Heavy Ion Collider (RHIC). Given the wide range of ion masses, energies and beam intensities the Booster will generate, other important applications should be considered. Dedicated use of the Booster for such applications may be possible during limited periods. However shared use would be preferable from the points of view of availability, affordability and efficiency. While heavy ions of a given isotope are injected into the AGS, the same or other ion species from the Booster could be simultaneously delivered to a new irradiation area for treatment of patients, testing of electronic devices or other applications and research. To generate two different beam species, ion sources on both Tandem accelerators would be used; one for AGS injection and the other one for a time-sharing application. Since the beam transport from the Tandems to the Booster can not be rapidly adjusted, it will be necessary to select beams of identical magnetic rigidity. The present study was performed to determine to what extent this compatibility requirement imposes limitations on the available ion species, energies and/or intensities.

32908 (ISN–89-46) **News developments at Sara.** Belmont, J.L.; Fruneau, M.; Martin, P. Grenoble-1 Univ., 38 (France). Inst. des Sciences Nucleaires. May 1989. 5p. (CONF-890560–: 12. international conference on cyclotrons and their applications, Berlin (Germany, F.R.), 8-12 May 1989). Order Number DE90792922. Available from NTIS (US Sales Only), PC A02/MF A01.

SARA was one of the first cyclotrons to operate with an ECR ion source. Experience since 1983 showed it would be useful to have two sources situated outside the cyclotron vault to manage continuous operation of the accelerator and development of new ions. A 18 m long injection line for FERROMAFIOS and MINIMAFIOS has been constructed. One of its principal features is a 11 m long electrostatic guide with periodic focusing. Transmission ratios from the source to the internal beam are close to 30%. Experiences involving time of flight measurements require short beam bunches; in order to reduce their duration, a phase selecting system will be installed in the centre of the injector of SARA. A RF voltage at four

times the frequency of the dees will vertically deflect early orbits while particles close to the central phase will cross the deflector at zero voltage and will undergo normal acceleration.

32909 (KEK–89-14, pp. 73-80) **Experimental studies of V_pxB electron linear accelerator.** Taura, T. (Utsunomiya Univ. (Japan). Faculty of Engineering); Onihashi, H.; Otsuka, K.; Nishida, Y.; Yugami, N. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Oct 1989. (CONF-8908213–: Workshop on role of plasmas in accelerators, Tsukuba (Japan), 21 Aug 1989). In *Proceedings of the workshop on role of plasmas in accelerators.* Order Number DE90759999. Available from NTIS (US Sales Only), PC A06/MF A01.

In order to demonstrate a new electron linear accelerator an electron beam is accelerated either in the conventional linear accelerator scheme or in the V_pxB scheme in a same machine and higher energy gain of about 18 % is observed in the V_pxB scheme as is expected from the designed values. The experimental results are compared with the numerical simulation to show reasonable agreement. (author).

32910 (SLAC-PUB–5226) **Datum definition problems in accelerator alignment.** Bell, B.; Friedsam, H.; Oren, W.; Ruland, R. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Apr 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-9003158–1: ACSM-ASPRS spring convention, Denver, CO (USA), 19-23 Mar 1990). Order Number DE90010311. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Any measurement task requires a fixed reference base (the datum) from which measurements can be made and calculated. The linac was the datum to which all SLC components were aligned; although this reference existed as a physical object, the actual establishment of the datum and its transferral to datums that were more useful for the SLC installation challenged the technology and computational ability of the survey group. Once established, the maintenance of datums is not to be taken for granted, as demonstrated by the 1989 earthquake which destroyed all SLAC's survey datums. 7 refs., 6 figs.

32911 Development and testing of the Hermes-III pulse forming transmission lines. Corley, J.P. (Sandia National Labs., Albuquerque, NM (USA)); Johnson, D.L.; Weber, G.J.; Denison, G.J.; Pankuch, P.J.; Ramirez, J.J. 486-489 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B. H.; Turchi, P. J. IEEE Service Center, Piscataway, NJ (USA) (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

In Hermes III, eighty pulse-forming lines (PFLs) generate 1.1-MV, 220-kA pulses that are added in a parallel/series combination to form a 20-MV, 800-kA pulse that powers an electron beam diode configured to produce bremsstrahlung radiation. In order to achieve the desired pulse width and rise time at the diode, each PFL must produce a 40-ns FWHM pulse with a 10-ns, 10% to 90% rise time and a root mean square (rms) jitter of 4 ns. This paper reports on the development and testing of these units.

32912 High average-power induction linacs. Prono, D.S.; Barrett, D.; Bowles, E.; Caporaso, G.J.; Chen, Yu-Jiuan; Clark, J.C.; Coffield, F.; Newton, M.A.; Nexsen, W.; Ravenscroft, D. 1440-1445 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Induction linear accelerators (LIAs) are inherently capable of accelerating several thousand amperes of $\sim$ 50-ns duration pulses to $>$ 100 MeV. In this paper the authors report progress and status in the areas of duty factor and stray power management. These technologies are vital if LIAs are to attain high average power operation. 13 figs.

32913 Applications of modern filtering to accelerators. Zhang, Shou-Yuan (Brookhaven National Laboratory, Upton, NY (USA)). 1626-1628 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The conventional filtering approaches (including the digital filter) postulate that the useful signals lie in a frequency band, while the noises lie in another. The modern filtering approaches however identify the signals from their statistical properties, and can be applied in the following categories: real time filtering, for control; smoothing, for analysis; and prediction, for control with delay factors. The data acquisition, computer calculation, system modeling, and noise statistics identification are required in the implementation of a modern filtering. For the detailed treatment of the modern filtering and its properties, readers are referred to. For the various applications, readers are referred to. In this paper, the authors shall present the modern filtering applications in the Accelerator technologies. To make the paper self-contained we shall go through every step for the design of a modern filtering from the filtering formulation, system modeling, to the application. In Section II, the authors present the modern filtering formulation for the simplest case of the single-variable filtering with a first order system. In Section III, the authors show the system modeling for the AGS Slow Extracted Beam (SEB) system. In Section IV, the authors show the SEB filtering. The last section is devoted for the discussion of other applications. 4 refs., 6 figs.

32914 The SHOT SUMMARY system for the Tevatron collider. Gelfand, N. (Fermi National Accelerator Laboratory, Batavia, IL (USA)); Martensson, E. 1633-1635 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Data from numerous devices in the Tevatron Collider are routinely logged and the data stored in files on the Accelerator Division Vax Cluster. The data in these files are necessary for an understanding the performance of the Tevatron Collider and for its improvement. Periodically these files are accessed and the data for a subset of the devices are retrieved. These data are checked, and if warranted by the type of data, averaged and then stored in a relational data base (RIM). The data in the data base can be retrieved by programs written in high level languages i.e. PASCAL and FORTRAN. As an example a SHOT SUMMARY PROGRAM written in PASCAL is used to study performance of a store. 4 figs.

32915 Control system for the Neutron Therapy Facility at Fermilab. Shea, M.F. (Fermi National Accelerator Laboratory, Batavia, IL (USA)); Florian, R.J.; Goodwin, R.W.; Lennox, A.J.; Shea, D.M. 1660-1662 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A new real time control and calibration system has been installed at the Fermilab Neutron Therapy Facility. An IBM-PC/AT user console is networked to the VMEbus-based front-end computers using a Token Ring local area network. Two 68000-based single board computers are used in the front end station to isolate the time-critical dose measurement and accumulation tasks from the network functions. The system is fabricated from commercially available computer, memory and data acquisition cards. Software in the front end processors is written in assembly language, but application programs for the IBM-PC/AT are written in Turbo Pascal. Chamber calibration, beam calibration and patient dose delivery functions are all controlled through the IBM-PC/AT by the radiation therapists. Records of each treatment are printed automatically after the prescribed dose is delivered. 2 refs., 2 figs.

32916 Relational databases for SSC design and control. Barr, E. (Lawrence Berkeley Laboratory, CA (USA)); Peggs, S.; Saltmarsh, C. 1666-1668 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator

conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Most people agree that a database is A Good Thing, but there is much confusion in the jargon used, and in what jobs a database management system and its peripheral software can and cannot do. During the life cycle of an enormous project like the SSC, from conceptual and theoretical design, through research and development, to construction, commissioning and operation, an enormous amount of data will be generated. Some of these data, originating in the early parts of the project, will be needed during commissioning or operation, many years in the future. Two of these pressing data management needs-from the magnet research and industrialization programs and the lattice design-have prompted work on understanding and adapting commercial database practices for scientific projects. Modern relational database management systems (rDBMS's) cope naturally with a large proportion of the requirements of data structures, like the SSC database structure built for the superconduction cable supplies, uses, and properties. This application is similar to the commercial applications for which these database systems were developed. The SSC application has further requirements not immediately satisfied by the commercial systems. These derive from the diversity of the data structures to be managed, the changing emphases and uses during the project lifetime, and the large amount of scientific data processing to be expected. 4 refs., 5 figs.

32917 **Plasma compensation effects with relativistic electron beams.** Autin, B. (Lawrence Berkeley Lab., CA (USA)); Sessler, A.M.; Whittum, D.H. 1812-1814 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A sufficiently dense plasma can neutralize the current of a high energy lepton beam propagating through it. The authors have studied an e^+-e^- linear collider design with this plasma compensation and found that high luminosities can be obtained without going to nanometer beam sizes currently being discussed. The authors have also studied the consequence of compensation on B-factory design. One severe limitation on such plasma based device which has not been thoroughly examined is the background due to the interaction of the high energy beams with the plasma ion nuclei. 8 refs., 1 fig., 1 tab.

32918 **Operation of a bidirectional voltage-dividing bremsstrahlung diode.** Harper-Slaboszewicz, V.J. (Sandia National Laboratories, Albuquerque, New Mexico 87185 (USA)); Lee, J.R.; Hedemann, M.A.; Baldwin, G.T.; Poukey, J.W.; Lorence, L.J. Jr.; Carlson, G.A.; Fowler, W.E.; Faucett, D.L.; Landron, C.O. *Journal of Applied Physics (USA)*, 67(7): 3233-3242 (1 Apr 1990). DOE Contract AC04-76DP00789.

Operation of a new type of high-power electron diode, the bidirectional voltage-dividing (BVD) diode, has been demonstrated on a 1-MV, 2.5-MA, 20-ns accelerator. This diode consists of a forward- and an inverse-triaxial diode in series. The diode impedance and electron flow pattern agreed reasonably well with particle-in-cell code calculations. The radiation spectrum was measured using two different diagnostics, a differential absorption spectrometer and the time-projection Compton spectrometer. Operating at a voltage of 850–1000 kV, the BVD diode produced a bremsstrahlung spectrum similar to that produced by a standard diode operating at 350–500 kV.

4302 Beam Dynamics, Field Calculations, and Ion Optics

Refer also to citation(s) 32917, 32946, 32955, 33398

32919 (ANL/APS-TM-5) **Proceedings of the impedance and bunch instability workshop.** Argonne National Lab., IL (USA). Advanced Photon Source Accelerator Systems Div. Apr 1990. 275p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. (CONF-8910357–: Impedance and bunch instability workshop, Argonne, IL (USA), 31 Oct - 1 nov 1989). Order Number DE90010201. Available from NTIS, PC A12/MF A01; OSTI; INIS; GPO Dep.

This report discusses the following topics: impedance and bunch lengthening; single bunch stability in the ESRF; a longitudinal mode-coupling instability model for bunch lengthening; high-frequency behavior of longitudinal coupling impedance; beam-induced energy spreads at beam-pipe transitions; on the calculation of wake functions using MAFIA-T3 code; preliminary measurements of the bunch length and the impedance of LEP; measurements and simulations of collective effects in the CERN SPS; bunch lengthening in the SLC damping rings; and status of impedance measurements for the spring-8 storage ring.

32920 (BNL–44583) **Orbit calculations and lattice parameters for the BNL [Brookhaven National Laboratory] SXLS [Superconducting X-Ray Lithography Source]: Part 2, Betatron functions in the superconducting bending magnet and synchrotron radiation integrals.** Blumberg, L.N.; Murphy, J.B. Brookhaven National Lab., Upton, NY (USA). May 1990. 30p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. Order Number DE90011121. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In a previous report we described the method for integration of the equations of motion in cylindrical coordinates through the nonlinear magnetic fields of the 180 degree SXLS bending magnets using a 4th order Runge-Kutta method and fields generated by the TOSCA program. Closed orbits were calculated for a sample two-coil conductor configuration – one coil above and below the median plane – and tunes of small amplitude oscillations about these orbits were evaluated. Several values of the betatron functions beta and eta were obtained at convenient points in the lattice where the alpha function was zero. In the present report, we describe the method for calculating the $\alpha,\beta,\eta$and η' functions along the closed orbit within the magnet as well as the normalized field index function n/ρ^3, where ρ is the radius of curvature. The functions are then used to evaluate the synchrotron radiation integrals which yield the physical properties of the ring such as energy and betatron oscillation damping times, the damped emittance, and the energy loss per turn. These qualities are compared to previous calculations of Murphy and Vignola, who used a combined dipole plus gradient magnet with linear fringe field drop-off, and the agreement is excellent. 8 refs., 9 figs., 6 tabs.

32921 (CEA-CONF–9798) **Photo-injector, accelerator chain and wiggler development programs for a high peak power RF-Free electron laser.** Dei-Cas, R. (and others); Balleyguier, P.; Bardy, J. CEA Centre d'Etudes de Bruyeres-le-Chatel, 91 (France). 1988. 11p. (CONF-8808146–: 10. international free-electron laser conference, Jerusalem (Israel), 29 Aug - 2 sep 1988). Order Number DE90792957. Available from NTIS (US Sales Only), PC A03/MF A01.

Strong constraints are imposed on the main components of a RF linac to reach high peak power in a free electron laser. To get high beam qualities, development programs and prototype realizations have been engaged on the following topics: - a low-frequency photo-injector running at 144 MHz, - an accelerator chain prototype at 433 MHz including a 6 MW peak power klystron with 200 μs pulse duration, a hard tube modulator and a 3-cell cavity, - an adjustable hybrid tapered wiggler with online feedback control.

32922 (DOE/ER/10666–8) **Advanced methods for the computation of particle beam transport and the computation of electromagnetic fields and beam-cavity interactions: Annual report.** Dragt, A.J.; Gluckstern, R.L. Maryland Univ., College Park, MD (USA). Dept. of Physics and Astronomy. Apr 1990. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AS05-80ER10666. Order Number DE90011071. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The University of Maryland Dynamical Systems and Accelerator Theory Group carries out research in two broad areas: the computation of charged particle beam transport using Lie algebraic methods and advanced methods for the computation of electromagnetic fields and beam-cavity interactions. Important improvements in the state of the art are believed to be possible in

both of these areas. In addition, applications of these methods are made to problems of current interest in accelerator physics including the theoretical performance of present and proposed high energy machines. The Lie algebraic method of computing and analyzing beam transport handles both linear and nonlinear beam elements. Tests show this method to be superior to the earlier matrix or numerical integration methods. It has wide application to many areas including accelerator physics, intense particle beams, ion microprobes, high resolution electron microscopy, and light optics. With regard to the area of electromagnetic fields and beam cavity interactions, work is carried out on the theory of beam breakup in single pulses. Work is also done on the analysis of the high frequency behavior of longitudinal and transverse coupling impedances, including the examination of methods which may be used to measure these impedances. Finally, work is performed on the electromagnetic analysis of coupled cavities and on the coupling of cavities to waveguides.

32923 (INS–794) **Structure and RF characteristics of the INS 25.5-MHz split coaxial RFQ.** Tokuda, N.; Arai, S.; Imanishi, A.; Morimoto, T.; Tojyo, E.; Shibuya, S. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Nov 1989. 3p. Order Number DE90791076. Available from NTIS (US Sales Only), PC A02/MF A01.

A 25.5-MHz split coaxial RFQ cavity, 0.90 m in inner diameter and 2.1 m in length, has been fabricated and settled in INS. The electric field for acceleration and focusing is generated by four modulated vanes. In the vane alignment, an accuracy better than ± 40 μm (the average bore radius r_0 is 0.946 cm) has been attained. The resonant frequency has been tuned to 25.45 MHz; the frequency will be finally adjusted to 25.5 MHz by using a movable inductive tuner. According to a tentative measurement, the field strengths between neighboring vanes are same within ± 1 %. This paper describes the cavity structure, the design procedure, and preliminary results on rf characteristics of the cavity. (author).

32924 (KEK–89-14, pp. 16-28) **Numerical simulation of multi-EM-beam electron accelerator.** Otsuka, K. (Utsunomiya Univ. (Japan). Faculty of Engineering); Nishida, Y. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Oct 1989. (CONF-8908213–: Workshop on role of plasmas in accelerators, Tsukuba (Japan), 21 Aug 1989). In *Proceedings of the workshop on role of plasmas in accelerators.* Order Number DE90759999. Available from NTIS (US Sales Only), PC A06/MF A01.

In a new acceleration scheme; Multi-Electromagnetic-wave beam system, an obliquely propagating apparent wave has a phase velocity smaller than a speed of light. Then the interaction between the wave and electrons is easily realized. By numerical simulations, it is clearly seen in the phase space representation that the electrons with proper initial conditions can be trapped in the wave trough to be accelerated up to a speed of light. (author).

32925 (N–90-15743) **Simulation of radial expansion of an electron beam injected into a background plasma.** Koga, J.; Lin, C.S. Southwest Research Inst., San Antonio, TX (USA). 1989. 22p. (NASA-CR–186188;NAS–1.26:186188). Available from NTIS, PC A03/MF A01.

A 2-D electrostatic particle code was used to study the beam radial expansion of a nonrelativistic electron beam injected from an isolated equipotential conductor into a background plasma. The simulations indicate that the beam radius is generally proportional to the beam electron gyroradius when the conductor is charged to a large potential. The simulations also suggest that the charge buildup at the beam stagnation point causes the beam radial expansion. From a survey of the simulation results, it is found that the ratio of the beam radius to the beam electron gyroradius increases with the square root of beam density and decreases inversely with beam injection velocity. This dependence is explained in terms of the ratio of the beam electron Debye length to the ambient electron Debye length. These results are most applicable to the SEPAC electron beam injection experiments from Spacelab 1, where high charging potential was observed.

32926 Time-dependent degradation of an ion-focused ATA beam. Fawley, W.M.; Boyd, J.K.; Caporaso, G.J.; Chambers, F.W.; Chong, Y.P.; Hildum, J.S.; Lee, P.; Orzechowski, T.J.; Rogers, D.R.; Struve, K.W. 1489-1491 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The authors have made detailed measurements of the time-dependent beam quality of an ATA pulse transported on a KrF laser-photoionized benzene channel. The authors have found that the tail portion ($\tau \geq$ 20-30 ns) of the pulse becomes severely degraded both at high currents ($I >$ 3kA) and at long transport distances. Non-axisymmetric channel ion motion is suspected as the predominant source of the problem. The authors discuss various experiments which varied laser properties (timing, fluence, profiles), background ion pressure, and electron beam current in order to study the physics behind this degradation. 4 refs., 2 figs.

32927 Interactive beam tuning simulator for the SLC Final Focus. Ford, W.T. (Univ. of Colorado, Boulder (USA)); Kozanecki, W.; Lohse, T.; Servranckx, R.V. 1684-1686 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

An interface to the DIMAD beam optics computer program enables the operator to perform in simulation the sequence of magnet adjustments that would be used online for tuning the Stanford Linear Collider Final Focus System. The program accepts any input beam matrix from a disk file and presents a menu of magnet adjustments and scan and display options. The results of a ray trace calculation are presented as profiles or envelope plots on the graphics screen. The authors give results from studies of the optimization of the beam under various input conditions. 11 refs. 4 figs.

32928 Operating experience with the Argonne PIIECR ion source system. Pardo, R.C. (Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Illinois 60439 (US)); Billquist, P.J. *Review of Scientific Instruments (USA),* 61(1): 239-241 (Jan 1990). DOE Contract W-31109-ENG-38. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

The Argonne PIIECR ion source is the first ECR ion source system to operate on a high-voltage (350 kV) platform. The system is the injector into a new superconducting linac which will eventually provide beams over the entire periodic table, including uranium. The experience we have had with the system to date will be discussed. Emphasis will be placed on the source performance with solid materials and the initial performance of the system as an injector to the superconducting linac. The bunching system which is part of the overall source system allows a determination of the system longitudinal emittance. Results of these initial measurements will be presented.

32929 Plasma lenses for focusing particle beams. Su, J.J. (Department of Physics, University of California at Los Angeles, Los Angeles, California 90024 (USA)); Katsouleas, T.; Dawson, J.M.; Fedele, R. *Physical Review, A (General Physics) (USA),* 41(6): 3321-3331 (15 Mar 1990). DOE Contract AS03-83ER40120;FG03-87ER13752.

The focusing of particles by a thin plasma lens is analyzed with physical, linearized fluid and particle-in-cell computational models. For parameters similar to next-generation linear colliders, the plasma lens strength can exceed 100 MG/cm, and the luminosity can be enhanced by an order of magnitude by passing each beam through an appropriate plasma slab. The plasma electrons affect the focusing by shifting so as to (partially or completely) charge neutralize the beam. Both overdense and underdense plasma lenses are described (plasma density n_0 greater or less than beam density n_b). The former case applies equally well to e^+ and e^- beams, while the latter has distinct advantages for e^- beams (including smaller aberrations and background). The effects of spherical and longitudinal aberrations, emittance, plasma boundaries, and non-linear-plasma dynamics on the final spot size are discussed.

4303 Auxiliaries and Components

Refer also to citation(s) 32912, 32913, 32914, 32915, 32926, 32928, 32961, 32962, 32963, 32964, 32966, 33009, 33349, 33828

32930 (BNL–43273) **Summary of construction details and test performance of recent series of 1.8 meter SSC dipoles at BNL.** Goodzeit, C.; Wanderer, P. Brookhaven National Lab., Upton, NY (USA). [1990]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900348–3: 2. international industrial symposium on the super collider, Miami, FL (USA), 14-16 Mar 1990). Order Number DE90010645. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Certain design features of the SSC dipole magnets are evaluated with 1.8-meter models built and tested at BNL. We report the results of recent tests of such magnets relating quench performance and field quality measurements to mechanical design and assembly features such as collar material, collared coil dimensions and fit with the yoke and coil prestress level. 9 figs., 5 tabs.

32931 (BNL–43413) **The magnet components database system.** Baggett, M.J. (Brookhaven National Lab., Upton, NY (USA)); Leedy, R.; Saltmarsh, C.; Tompkins, J.C. Brookhaven National Lab., Upton, NY (USA). [1990]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900348–7: 2. international industrial symposium on the super collider, Miami, FL (USA), 14-16 Mar 1990). Order Number DE90011202. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The philosophy, structure, and usage MagCom, the SSC magnet components database, are described. The database has been implemented in Sybase (a powerful relational database management system) on a UNIX-based workstation at the Superconducting Super Collider Laboratory (SSCL); magnet project collaborators can access the database via network connections. The database was designed to contain the specifications and measured values of important properties for major materials, plus configuration information (specifying which individual items were used in each cable, coil, and magnet) and the test results on completed magnets. These data will facilitate the tracking and control of the production process as well as the correlation of magnet performance with the properties of its constituents. 3 refs., 10 figs.

32932 (CONF-9003154–2) **Spectral characteristics of insertion device sources at the Advanced Photon Source.** Viccaro, P.J. Argonne National Lab., IL (USA). [1990]. 46p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Workshop on atomic physics at the Advanced Photon Source; Argonne, IL (USA); 23-30 Mar 1990. Order Number DE90011099. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The 7-GeV Advanced Photon Source (APS) synchrotron facility at Argonne National Laboratory will be a powerful source of hard x-rays with energies above 1 keV. In addition to the availability of bending magnet radiation, the storage ring will have 35 straight sections for insertion device (ID) x-ray sources. The unique spectral properties and flexibility of these devices open new possibilities for scientific research in essentially every area of science and technology. Existing and new techniques utilizing the full potential of these sources, such as the enhanced coherence, unique polarization properties, and high spectral brilliance, will permit experiments not possible with existing sources. In the following presentation, the spectral properties of ID sources are briefly reviewed. A summary of the specific properties of sources planned for the APS storage ring is then presented. Recent results for APS prototype ID sources are discussed, and finally some special x-ray sources under consideration for the APS facility are described. 9 refs.

32933 (JAERI-M–89-182) **Development of high-power X-ray generation target for radiation processing.** Sunaga, Hiromi (Japan Atomic Energy Research Inst., Takasaki, Gunma (Japan). Takasaki Radiation Chemistry Research Establishment); Tanaka, Susumu; Kanazawa, Takao. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 35p. (In Japanese). Order Number DE90791077. Available from NTIS (US Sales Only), PC A03/MF A01.

An X-ray generation target system attaching to an electron irradiator was developed for application of bremsstrahlung radiation to radiation processing. For designing an industrial X-ray source, the electron accelerator assumed to provide the beam power of 5 MeV, 300 kW. Two different type targets, 'plane plate' and 'curvature types', were made on trial basis to obtain the engineering data required for the target design, and were installed under a 2 MeV, 60 kW electron irradiator for testing X-ray generation. The result showed that the 'curvature type' had good performance for high-power X-ray generation. A 'curvature type' target for industrial use was designed based on above results. (author).

32934 (KEK–89-9) **A colloidal solution of Fe_3O_4 crystallites to optically locate the magnetic center of multipole magnets.** Sugahara, Ryuhei; Kubo, Tadashi; Oosawa, Yasunobu. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Sep 1989. 6p. Order Number DE90791246. Available from NTIS (US Sales Only), PC A02/MF A01.

In the alignment of accelerator components or beam transports components along the beam line, it is important to identify the magnetic center of multipole magnets, which does not necessarily coincide with the mechanical center. The position of the magnetic center of magnets can be located by using a colloidal solution of Fe_3O_4 crystallites with a high resolution of about 10 μm. This is because the magnetic center can be observed visually and neither elaborate equipment nor accurate adjustment of the colloidal solution is necessary. A colloidal solution of Fe_3O_4 crystallites is prepared and its performance is examined. The life time of the scattering pattern formed by the scattering of plane-polarized light in the colloidal solution is found to be longer than two days, which is much longer than the pattern life of about 40 minutes for commercial colloidal solution. The reproducibility of the alignment of the hair cross of the telescope onto the cross point of the pattern is less than 20 μm. It is suggested that polydextrose, a soluble derivative of cellulose, can be effective in improving the pattern life. (N.K.).

32935 (KEK–89-11) **The shielding design methods of the synchrotron radiation facility, 1: Accelerator.** Ban, Syuichi; Hirayama, Hideo. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Sep 1989. 39p. (In Japanese). Order Number DE90791081. Available from NTIS (US Sales Only), PC A03/MF A01.

Various problems for designing the shield of the synchrotron radiation facility are summalized and discussed. The characteristics of the radiation fields and of the administration on radiation protection around the facility are also presented. (author).

32936 (KEK–89-14, pp. 1-3) **High intensity short pulse generation at ILE Osaka University.** Daido, H. (Osaka Univ., Suita (Japan). Inst. of Laser Engineering); Yamakawa, K.; Shiraga, H.; Kato, Y.; Nakai, S. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Oct 1989. (CONF-8908213–: Workshop on role of plasmas in accelerators, Tsukuba (Japan), 21 Aug 1989). In *Proceedings of the workshop on role of plasmas in accelerators*. Order Number DE90759999. Available from NTIS (US Sales Only), PC A06/MF A01.

Ultra-high intensity short pulse generation program including some applications of ultra high electric field and energy density is presented. Current status of laser systems are also presented. (author).

32937 (SAND–90-0394C) **Dosimetry considerations for the high-energy photon/electron environment of HERMES III: Implications for experiments and modeling.** Beutler, D.E. (Sandia National Labs., Albuquerque, NM (USA)); Halbleib, J.A.; Sanford, T.W.L.; Knott, D.P. Sandia National Labs., Albuquerque, NM (USA). [1990]. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900723–8: 27. IEEE annual international nuclear and space radiation effects conference, Reno, NV (USA), 16-20 Jul 1990). Order Number DE90007073. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Measurements of energy deposition as function of equilibrator thickness and position in the HERMES III radiation field are compared to ITS code predictions. The onset of dose-rate effects in CaF_2 TLDs have also been observed at 10^{10} Gy/s levels. 10 refs., 3 figs.

32938 (SLAC-PUB–5211) **Performance measurements of hybrid PIN diode arrays.** Jernigan, J.G. (California Univ., Berkeley, CA (USA). Space Sciences Lab.); Arens, J.F.; Kramer, G.; Collins, T.; Herring, J.; Shapiro, S.L.; Wilburn, C.D. Stanford Linear Accelerator Center, Menlo Park, CA (USA). May 1990. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-900348–5: 2. international industrial symposium on the super collider, Miami, FL (USA), 14-16 Mar 1990). Order Number DE90010308. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

.We report on the successful effort to develop hybrid PIN diode arrays and to demonstrate their potential as components of vertex detectors. Hybrid pixel arrays have been fabricated by the Hughes Aircraft Co. by bump bonding readout chips developed by Hughes to an array of PIN diodes manufactured by Micron Semiconductor Inc. These hybrid pixel arrays were constructed in two configurations. One array format having 10 × 64 pixels, each 120 μm square, and the other format having 256 × 256 pixels, each 30 μm square. In both cases, the thickness of the PIN diode layer is 300 μm. Measurements of detector performance show that excellent position resolution can be achieved by interpolation. By determining the centroid of the charge cloud which spreads charge into a number of neighboring pixels, a spatial resolution of a few microns has been attained. The noise has been measured to be about 300 electrons (rms) at room temperature, as expected from KTC and dark current considerations, yielding a signal-to-noise ratio of about 100 for minimum ionizing particles. 4 refs., 13 figs.

32939 (SLAC-PUB–5243) **Computing and data handling requirements for SSC [Superconducting Super Collider] and LHC [Large Hadron Collider] experiments.** Lankford, A.J. Stanford Linear Accelerator Center, Menlo Park, CA (USA). May 1990. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-9004190–2: Computing in high energy physics, Santa Fe, NM (USA), 9-13 Apr 1990). Order Number DE90010310. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A number of issues for computing and data handling in the online in environment at future high-luminosity, high-energy colliders, such as the Superconducting Super Collider (SSC) and Large Hadron Collider (LHC), are outlined. Requirements for trigger processing, data acquisition, and online processing are discussed. Some aspects of possible solutions are sketched. 6 refs., 3 figs.

32940 (UCRL–102623) **Induction linac energy regulation via injector current modulation.** Bowles, E.E. (General Atomics, San Diego, CA (USA)); Turner, W.C. Lawrence Livermore National Lab., CA (USA). [1990]. 4p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. Contract W43-GBL-0-5007. (CONF-9006176–1: 19. power modulator symposium, San Diego, CA (USA), Jun 1990). Order Number DE90010678. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A 16-MW, 30-MHz electron beam current modulator has been built and tested at Lawrence Livermore National Laboratory. The modulator utilizes the transconductance of an array of 32 planar triode tubes to shunt a voltage regulation cell which will be added to the electron beam injector of an induction linac. The modulator exerts analog control over the top 5% of the injector current pulse. It will operate on a 60-ns beam pulse up to a 0.1% duty cycle.

32941 (UCRL–102982) **LLNL/UC [Lawrence Livermore National Laboratory]/[University of California] AMS [accelerator mass spectrometry] facility and research program.** Davis, J.C.; Proctor, I.D.; Southon, J.R.; Caffee, M.W.; Heikkinen, D.W.; Roberts, M.L.; Moore, T.L.; Turteltaub, K.W.; Nelson, D.E.; Loyd, D.H. Lawrence Livermore National Lab., CA (USA). 18 Apr 1990. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900491–2: 5. international conference on accelerator mass spectrometry, Paris (France), 23-27 Apr 1990). Order Number DE90010864. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Lawrence Livermore National Laboratory (LLNL) and the University of California (UC) now have in operation a large AMS spectrometer built as part of a new multiuser laboratory centered on an FN tandem. AMS measurements are expected to use half of the beam time of the accelerator. LLNL use of AMS is in research on consequences of energy usage. Examples include global warming, geophysical site characterization, radiation biology and dosimetry, and study of mutagenic and carcinogenic processes. UC research activities are in clinical applications, archaeology and anthropology, oceanography, and geophysical and geochemical research. Access is also possible for researchers outside the UC system. The technological focus of the laboratory is on achieving high rates of sample through-put, unattended operation, and advances in sample preparation methods. Because of the expected growth in the research programs and the other obligations of the present accelerator, we are designing a follow-on dedicated facility for only AMS and microprobe analysis that will contain at least two accelerators with multiple spectrometers. 10 refs., 1 fig.

32942 (UCRL–102983) **The new LLNL AMS spectrometer.** Southon, J.R.; Caffee, M.W.; Davis, J.C.; Moore, T.L.; Proctor, I.D.; Schumacher, B.; Vogel, J.S. Lawrence Livermore National Lab., CA (USA). 18 Apr 1990. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900491–4: 5. international conference on accelerator mass spectrometry, Paris (France), 23-27 Apr 1990). Order Number DE90010868. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The multi-user tandem laboratory at Lawrence Livermore is a new facility dedicated to AMS and a variety of other ion beam analysis techniques. The AMS spectrometer design aims and implementation are presented here, and present performance and planned improvements are discussed. 9 refs., 2 figs.

32943 (UCRL–102986) **Injection systems for AMS: Simultaneous vs. sequential.** Southon, J.R.; Nelson, D.E.; Vogel, J.S. Lawrence Livermore National Lab., CA (USA). 18 Apr 1990. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900491–3: 5. international conference on accelerator mass spectrometry, Paris (France), 23-27 Apr 1990). Order Number DE90010867. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Simon Fraser AMS spectrometer operated at McMaster University for a period of about 10 years. This instrument was unique in that the isotope beams of interest were injected into the accelerator simultaneously rather than sequentially, using an achromatic multi-magnet injector. As well, our group has also been involved in the design and operation of the LLNL spectrometer, which uses a more conventional fast pulsing sequential system. We compare our first- hand experience with the two systems and discuss the strengths and weaknesses of the different approaches. 7 refs., 6 figs.

32944 (UCRL–102987) **The LLNL [Lawrence Livermore National Laboratory] ion source: Past, present and future.** Proctor, I.D.; Southon, J.R.; Roberts, M.L.; Davis, J.C.; Heikkinen, D.W.; Moore, T.L.; Garibaldi, J.L.; Zimmerman, T.A. Lawrence Livermore National Lab., CA (USA). 18 Apr 1990. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900491–6: 5. international conference on accelerator mass spectrometry, Paris (France), 23-27 Apr 1990). Order Number DE90010870. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Multi-user Tandem Laboratory (MTL) at LLNL is a general purpose laboratory for analysis using ion beam techniques. Our initial interest in AMS was for large throughput with modest precision. Toward this goal, we purchased a prototype GIC spherical ionizer source with 60 sample cassette changer. The source has been extensively modified to increase reliability and to adapt it for AMS operation. The sample changing mechanism was completely rebuilt, pumping was increased in critical areas, electrical stress has been reduced in areas where failures were frequent and protection of insulators from cesium vapor has been increased. We are limiting the divergence to 20 mRad to match the present injection system and are only able to get about 50 microamps of stable carbon beam in this configuration. Details of failures, changes to date and planned improvements will be discussed. 6 refs.

32945 **Engineering design of the Saturn accelerator.** Boyes, J.D. (Sandia National Labs., Albuquerque, NM (USA)); Cap, J.S.; Douglas, G.M.; Franklin, T.L.; Hart, J.M.; Ives, H.C.; Robischon, S.J.; Smith, B.L.; Stoppkotte, W.O.; Van DeValde, D.M. 474-477 of

Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B. H.; Turchi, P. J. IEEE Service Center, Piscataway, NJ (USA) (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The Saturn accelerator is a large flash x-ray simulator. The performance goal of the machine is to provide x-ray exposure capabilities of 5 x 10^{12} rads/s (Si) and 5 cal/g (Au) uniformly distributed over a 500 cm^2 target area. The operational goal of the machine is to provide this exposure capability reliably in a multiple-shot-a-day mode. This paper describes the engineering designs which accomplish these goals.

32946 Optical Cherenkov measurements of emittance growth in the Advanced Test Accelerator beam under laser ion-guiding. Chong, Y.P. (Lawrence Livermore National Laboratory, CA (USA)); Deadrick, F.J.; Hirzel, D.G.; Kallman, J.S.; Lee, P.; Poulter, J.F.; Rivera, W.E.; Stephan, P.L.; Weir, J.T. 1495-1497 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A new beam profile diagnostic using optical Cherenkov radiation from a quartz foil has been deployed at the Advanced Test Accelerator (ATA) at Lawrence Livermore National Laboratory. Quartz has been found to perform better than previously tested foils (titanium and Kapton) in terms of damage threshold. The emission intensity from quartz is over an order of magnitude brighter than that from graphite foil. Data were taken at the beginning, middle, and end of ATA, i.e., at 3.8 MeV (cell 15), 22.5 MeV (cell 90), and 43 MeV (11 m beyond the end). Profile measurements of the ion-focused beam showed emittance growth through the pulse. Double-Gaussian fits to the radial profile were often superior to single-Gaussian fits and showed that a large beam dominated the second half of the pulse. This was observed for currents of 1, 3, and 7 kA at the accelerator output and at cell 15 for the 3-kA case. The dependence of emittance growth on several parameters was studied. 7 figs.

32947 Long ion chamber systems for the SLC (Stanford linear collider). Rolfe, J. (Stanford Univ., CA (USA)); Gearhart, R.; Jacobsen, R.; Jenkins, T.; McComick, D.; Nelson, R.; Reagan, D.; Ross, M. 1531-1533 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A Panofsky Long Ion Chamber (PLIC) is essentially a gas-filled coaxial cable, and has been used to protect the Stanford Linear Accelerator from damage caused by its electron beam, and as a sensitive diagnostic tool. This old technology has been updated and has found renewed use in the SLC. PLIC systems have been installed as beam steering aids in most parts of the SLC and are a part of the system that protects the SLC from damage by errant beams in several places. 5 refs., 3 figs., 1 tab.

32948 Beam diagnostic for COSY-Juelich. Maier, R. (Kernforschungsanlage Juelich GmbH (Germany, F.R.)); Hacker, U. 1574-1576 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The beam diagnostic system for the cooler synchrotron COSY-Juelich is discussed. The major components to determine the beam position, the beam intensity and the beam profile are described. The set-up of the phase measurement between the injector RF and the circulating bunches is shown. The description of the viewers for the run-in phase is given. The basic principles of the data processing by the distributed control system processors for automatic trajectory correction, stability checks, updating of beam position are discussed. The status of the diagnostic hardware and software is given together with the future plans. 3 refs., 5 figs., 1 tab.

32949 Accelerator diagnosis and control by Neural Nets. Spencer, J.E. (Stanford Univ., CA (USA)). 1642-1644 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Neural Nets (NN) have been described as a solution looking for a problem. In the last conference, Artificial Intelligence (AI) was considered in the accelerator context. While good for local surveillance and control, its use for large complex systems (LCS) was much more restricted. By contrast, NN provide a good metaphore for LCS. It can be argued that they are logically equivalent to multi-loop feedback/forward control of faulty systems and therefore provide an ideal adaptive control system. Thus, where AI may be good for maintaining a golden orbit, NN should be good for obtaining it via a quantitative approach to look and adjust methods like operator tweaking which use pattern recognition to deal with hardware and software limitations, inaccuracies or errors as well as imprecise knowledge or understanding of effects like annealing and hysteresis. Further, insights from NN allow one to define feasibility conditions for LCS in terms of design constraints and tolerances. Hardware and software implications are discussed and several LCS of current interest are compared and contrasted. 15 refs., 5 figs.

32950 The Colliding Beams Sequencer. Johnson, D.E. (Fermi National Laboratory, Batavia, IL (USA)); Johnson, R.P. 1657-1659 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The Colliding Beam Sequencer (CBS) is a computer program used to operate the pbar-p Collider by synchronizing the applications programs and simulating the activities of the accelerator operators during filling and storage. The Sequencer acts as a meta-program, running otherwise stand alone applications programs, to do the set-up, beam transfers, acceleration, low beta turn on, and diagnostics for the transfers and storage. The Sequencer and its operational performance will be described along with its special features which include a periodic scheduler and command logger. 14 refs., 3 figs.

32951 Status of superconducting RF cavity development. Shepard, K.W. (Argonne National Laboratory, IL (USA)). 1764-1768 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

For several reasons, a brief historical review seems appropriate at this time. The twenty-fifth anniversary of the first acceleration of beam with a superconducting cavity will occur shortly [1,2,3]. Also, the scope of accelerator applications of superconducting radio-frequency (SRF) devices has, within the last few months, begun to increase rapidly [4] - to the point that it seems likely that early expectations for this technology will largely be fulfilled. Since the object is to accelerate beam, a simple one parameter measure of the technology is the total of how much beam has been accelerated. Figure 1 shows the total accumulated voltage in tests and/or operation of superconducting accelerating cavities with beam, up to the time indicated, as reported in the open literature [4-35]. This parameter has been divided into two terms: first, the subtotal for electron accelerating velocity-of-light structures, and second the subtotal for low-velocity, ion accelerating structures. To restate: each of these terms represents as a function of time an integrated, accumulative total voltage produced by SRF hardware and demonstrated with beam. 56 refs., 4 figs.

32952 ERC sources for the production of highly charged ions (Invited). Lyneis, C.M. (Lawrence Berkeley Laboratory, Berkeley, California 94720 (US)); Antaya, T.A. *Review of Scientific Instruments (USA),* 61(1): 221-224 (Jan 1990). DOE Contract

AC03-76SF00098. (CONF-890703--: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

Electron cyclotron resonance ion sources (ECRIS) using rf between 5 and 16 GHz have been developed into stable, reliable sources of highly charged ions produced from a wide range of elements. These devices are currently used as ion sources for cyclotrons, synchrotrons, and heavy-ion linacs for nuclear and relativistic heavy-ion physics. They also serve the atomic physics community as a source of low energy multiply charged ions. In order to improve their performance both with respect to maximum charge state and beam intensity, ECRIS builders are now designing and constructing sources which will operate at frequencies up to 30 GHz. In this article we review the present status of operating ECRIS, review recent experimental measurements on plasma parameters, and look at the technology and potential of sources operating at frequencies up to 30 GHz.

32953 The KSU cryogenic electron-beam ion source. Stockli, M.P. (J.R. Macdonald Laboratory and Department of Physics, Kansas State University, Manhattan, Kansas 66506 (US)); Cocke, C.L.; Richard, P. *Review of Scientific Instruments (USA),* 61(1): 242-246 (Jan 1990). (CONF-890703--: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

We built a cryogenic electron-beam ion source which is now in operation. We report some experiences and results of the start-up phase, which was aimed at producing beams of highly charged argon. In March 1989 the first ions were extracted and identified as argon 17+ using Donets' x-ray technique. In April we started performing diagnostics with a 90° double-focusing analyzing magnet to study the charge-state distributions. In June we extracted beams with fully stripped argon 18+ as the most abundant argon charge state.

32954 Electron cyclotron resonance ion source frequency scaling and radial confinement in a quadrupole magnetic field. Pu, Y.K. (Spire Corp., Bedford, Massachusetts 01730 (US)); Halverson, W.; Petty, C.; Smatlak, D.; Torti, R. *Review of Scientific Instruments (USA),* 61(1): 276-278 (Jan 1990). DOE Contract AC02-87ER80451. (CONF-890703--: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

Experiments have been conducted on Constance B to study transport properties in electron cyclotron resonance (ECR) heated plasmas of high-charge-state neon ions. Measurements were made of confinement parallel and perpendicular to the magnetic field at heating frequencies of 10.5 and 14 GHz, and corresponding ECR magnetic field strengths. Although radial ion losses scaled approximately as B^{-2}, the total particle confinement time was independent of magnetic field. Thus, higher current densities of multicharged neon ions were extracted at higher ECR heating frequency and magnetic field.

32955 Analysis of the ion beam obtained from a small multicusp ion source. Langbein, K. (Insitut fuer Angewandte Physik, Universitaet Frankfurt, Robert-Mayer-Strasse 2-4, D-6000 Frankurt a. M., Federal Republic of Germany (DE)); Riehl, G.; Klein, H.; Walther, S.R.; Keller, R. *Review of Scientific Instruments (USA),* 61(1): 327-329 (Jan 1990). (CONF-890703--: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

The small multicusp ion source developed at Lawrence Berkeley Laboratory (LBL) has been equipped with a low voltage ratio, single aperture extraction system. The influence of the potential of the plasma electrode and of a dipole filter field on the beam emittance are measured. A simple method to reduce hash is suggested. The aim of these investigations is to produce nitrogen ion beams with a high atomic ion fraction and a low emittance as required for a RFQ-accelerator, which will be built for ion implantation.

32956 A high charge state multicusp ion source. Leung, K.N. (Accelerator and Fusion Research Division, Lawrence Berkeley Laboratory, 1 Cyclotron Road, Berkeley, California 94720 (US)); Keller, R. *Review of Scientific Instruments (USA),* 61(1): 333-335 (Jan 1990). DOE Contract AC03-76SF00098. (CONF-890703--: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

Attempts have been made to generate high charge state ion beams by employing a multicusp plasma source. Three experimental investigations have been performed at Lawrence Berkeley Laboratory (LBL) and at Gesellschaft fuer Schwerionenforschung, Darmstadt (GSI) to study the charge state distributions and the emittance of the extracted beam. Results demonstrate that charge state as high as +7 can be obtained with argon or xenon plasmas. The brightness of a 11-mA xenon ion beam is found to be 26 A/(π mm mrad)^2.

32957 High-intensity plasma-sputter heavy negative-ion source (invited). Alton, G.D. (Oak Ridge National Laboratory, P. O. Box 2008, Oak Ridge, Tennessee 37831-6368 (US)); Mori, Y.; Takagi, A.; Ueno, A.; Fukumoto, S. *Review of Scientific Instruments (USA),* 61(1): 372-377 (Jan 1990). DOE Contract AC05-84OR21400. (CONF-890703--: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

A multicusp magnetic field plasma-surface ion source, normally used for H^- ion-beam formation, has been modified for the generation of high-intensity, pulsed, heavy-negative-ion beams suitable for a variety of uses. A brief description of the source and basic pulsed-mode operational data (e.g., intensity versus cesium oven temperature, sputter probe voltage, and discharge pressure) are given. In addition, illustrative examples of intensity versus time and the mass distributions of ion beams extracted from a number of samples, along with emittance data, are also presented. Preliminary results obtained during dc operation of the source under low-discharge-power conditions suggest that sources of this type may alo be used to produce high-intensity (mA) dc beams.

32958 Sources of spin-polarized beams (invited). Clegg, T.B. (Department of Physics, University of North Carolina, Chapel Hill, North Carolina (USA)). *Review of Scientific Instruments (USA),* 61(1): 385-388 (Jan 1990). DOE Contract AC05-76ER01067;FG05-88ER40442. (CONF-890703--: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

Sources producing beams of spin-polarized atoms and ions are now widely used in nuclear physics. Modern systems are increasingly expensive and complex. They provide a variety of species and beam polarizations with intensities often sufficient for experimental needs. The laboratory seeking such a device for its program must evaluate a variety of options and match them to its accelerator, experimental program, and expected resources. The major systems and techniques used are surveyed and criteria dictating the choice of source for particular experimental applications are discussed briefly.

4304 Storage Rings

Refer also to citation(s) 32916

32959 (GAO/GGD-89-104) **Information dissemination: Cost of mailing environmental impact statement for super collider.** General Accounting Office, Washington, DC (USA). General Government Div. Aug 1989. 10p. Available from US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877 (USA).

As part of its process for selecting a site for the $11-billion superconducting super collider, the Department of Energy sent about 17,000 copies of its four-volume, 8,000-page environmental impact statement to about 16,800 agencies, organizations, and individuals at the seven site alternatives. The cost for printing and distributing the document was about $1.4 million. Although DOE's actions and decisions were within the discretion allowed by law and regulation, GAO believes that DOE could have met federal regulations with a shorter environmental impact statement and with a more limited distribution, thus reducing printing and mailing costs. This paper reports on the GAO report on information dissemination by the Department of Energy.

32960 (GAO/RCED-89-129BR) **Federal research: Final site selection process for DOE's super collider.** General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div. Jun 1989. 53p. Available from US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877 (USA).

Concern was raised about the Department of Energy's site selection process for the superconducting super collider, a $4.4 billion high-energy physics facility. In January 1989 the Secretary of Energy selected Texas as the site from among seven best qualified states. This paper summarizes a GAO report which found the task force relied on information provided by the states and verified data primarily through its site visits to the seven best qualified sites and the environmental impact statement process; there is no reason to question the decision to site the super collider in Texas, in evaluating and rating the sites the task force used DOE's technical and cost criteria and provided evidence to support its rating; and DOE and its contractors assessed the three concerns identified by Texas residents as part of the site evaluation and environmental impact statement process and determined that these concerns were not serious problems.

32961 (UCID–21937) **SSRL-PEP ring divertor channel entrance thermal stress analysis for new bending magnet loads.** Johnson, G.L. Lawrence Livermore National Lab., CA (USA). 30 Jan 1990. 45p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. Order Number DE90010350. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Very thin x-ray beams emerging from bending magnets on the Stanford SSRL electron-positron storage ring (PEP) impinge on the entrance to tangential divertor channels which lead to the experiment beam lines. This energy deposition causes highly localized heating in the channel structure. This, in turn, creates thermally induced stresses. LLNL completed seven analyses of a Al 6061-T6 divertor channel just downstream of an experimental undulator device to determine its temperature and thermally induced stress distribution resulting from this heating. The entrance structure of this the divertor channel is cooled by 30°C, water flowing in the beamwise direction at 6 gpm. The x-ray beam emanating from 15 GeV electrons in a 35 mA current should result in the entrance to the divertor channel operating at a peak temperature of 119°C with a resultant peak thermal stress at 48% of yield of Al 6061 at 119°C. The peak stress is linearly proportion to beam current. The peak stress is approximately proportional to the 2.7 power of the electron ring energy. 6 refs., 9 figs., 2 tabs.

32962 **Beam position monitors for the CESR linac.** Meller, R.E.; Sagan, D.; Dunnam, C.R. 1468-1470 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A beam position monitor (BPM) system for the CESR linac has been developed that is capable of measuring 100 μm displacements for bunches with 10^8 particles. Each BPM consists of four stripline electrodes and associated fast analog and digital processing networks. Using 1 GHz bandwidth DMOS switching technology, a fast analog sampler has been implemented which captures the positive portion of a BPM stripline signal while rejecting the negative-going reflection. Reduced bandwidth post-sampling dual slope integration yields effective cancellation of analog switch charge injection and drift effects. 4 figs.

32963 **Digital control of the LEP RF system.** Hansen, S. (CERN, Geneva (Switzerland)); Ciapala, E.; Collier, P.; Disdier, M. 1636-1638 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The RF system for the initial phase of LEP consists of eight identical units of 16 cavity assemblies with associated high power and control equipment. These units are installed underground, distant from the control center, and each one has around 2,500 parameters and status indications, all of which must be remotely accessible. Digital control is achieved by assigning a G64 based equipment controller crate to each major element of the unit linked by a bus to a VME based data manager with overall control and connection to the control network. It executes locally or remotely initiated complex control and surveillance procedures to simplify operation. The different classes of parameter and data are summarized. Interfacing and control within the equipment controllers and communication with the data manager are outlined. The form of equipment access functions and the development of complex control procedures are discussed. The implementation of corresponding functions at control console level is discussed. Finally experience with the six RF units presently installed is described. 4 refs., 3 figs.

32964 **Upgrading of TRISTAN by superconducting RF system.** Kojima, Y.; Akai, K.; Arinaga, M.; Asano, K.; Ezura, E.; Furuya, T.; Hara, K.; Hosoyama, K.; Kabe, A.; Kako, E. 1789-1791 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Energy upgrade of TRISTAN by superconducting RF system is progressing. Sixteen five-cell 508 MHz cavities made of niobium have been installed and started to operate in November 1988. Superconducting Cavities have brought up the energy of e^-e^+ to 30.4 GeV from 28.5 GeV with normal conducting RF system. Construction, vertical tests, horizontal tests and operation experience of three months are described. 4 refs., 5 figs., 2 tabs.

44 INSTRUMENTATION

32965 (SAND–90-0339) **Primary Standards Laboratory report: 2nd half 1989.** Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 33p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC04-76DP00789. Order Number DE90010298. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Sandia National Laboratories operates the Primary Standards Laboratory (PSL) for the Department of Energy, Albuquerque Operations Office (DOE/AL). This report summarizes metrology activities that received emphasis in the second half of 1989 and provides information pertinent to the operation of the DOE/AL system-wide Standards and Calibration Program. 7 refs.

4401 Radiation Instrumentation

Refer also to citation(s) 32197, 32941, 32942, 32943, 33042, 33398, 33404, 33405, 33539, 33541, 33747, 33748, 33755, 33789

32966 (ANL-HEP-CP–90-33) **Rad-hard electronics development program for SSC liquid-argon calorimeters.** Stevens, A. (Argonne National Lab., IL (USA). High Energy Physics Div.); Dawson, J.; Kraner, H.; Radeka, V.; Rescia, S. Argonne National Lab., IL (USA). High Energy Physics Div. [1990]. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. (CONF-900348–6: 2. international industrial symposium on the super collider, Miami, FL (USA), 14-16 Mar 1990). Order Number DE90011107. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The development program for radiation-hard low-noise low-power front-end electronics for SSC calorimetry is described. Radiation doses of up to 20 MRad and neutron fluences of 10^{14} neutrons/cm^2 are expected over ten years of operation. These effects are simulated by exposing JFETs to neutrons and ionizing radiation and measuring the resulting bias, leakage current and noise variations. In the case of liquid-argon calorimeters, a large part of the front-end circuitry may be located directly within the low-temperature environment (90 K), placing additional constraints on the choice of components and on the design. This approach minimizes the noise and the response time. The radiation damage test facilities at Argonne will also be described. These include sources of neutrons, electrons, and gamma radiation. 8 refs., 9 figs.

32967 (ANL-HEP-CP–90-34) **Radiation tolerance implications for the mechanical design of a scintillator calorimeter for the SSC.** Proudfoot, J. Argonne National Lab., IL (USA). High Energy Physics Div. [1990]. 4p. Sponsored by U.S. DOE Energy

Research. DOE Contract W-31109-ENG-38. (CONF-9003159–1: Workshop on radiation hardness of plastic scintillator, Tallahassee, FL (USA), 19-21 Mar 1990). Order Number DE90011112. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the issue of radiation damage in a sampling scintillator calorimeter with regard to the mechanical and optical design of such a device. Radiation damage is inevitable in some regions of the detector and the different damage and recovery time constants are compared to anticipated calibration data from W & Z Boson decays. Some plausible values for safety factors in the initial design are given. 5 refs., 1 fig.

32968 (BONN-IR–89-46) **Development of a large-area scintillation detector with good spatial resolution.** Beulertz, W. Bonn Univ. (Germany, F.R.). Physikalisches Inst.; Bonn Univ. (Germany, F.R.). Mathematisch-Naturwissenschaftliche Fakultaet. Nov 1989. 56p. (In German). Order Number DE90792235. Available from NTIS (US Sales Only), PC A04/MF A01.

This work describes the development of a large area scintillation counter which is able to determine simultaneously energy, impact position and time-of-flight information of an incoming particle. A model calculation is used to predict the achievable resolutions. They have been verified in a series of measurements using a test module to σ_X=5 mm, σ_E=0.7 MeV and σ_{TOF}=450 psec at 10 MeV of deposited energy. It is proposed to employ an adapted version of the counter in a measurement of η-photoproduction near threshold energy. (orig.).

32969 (CEA-R–5506) **Detection limits for Gamma-Ray spectral analysis.** CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Nov 1989. 176p. (In French). Order Number DE90792917. Available from NTIS (US Sales Only), PC A09/MF A01.

This paper presents a study concerning the formulation of sensitivity limits in radioactivity analysis using gamma-ray spectrometer. Expressions for practical evaluation of the detection level (SD) and the detection limit (LD) are given. The detection level is defined as a detection criterion (a posteriori) and the detection limit is defined either a posteriori, for undetected radionuclides, or a priori, for the weakest activity which can be detected in the analysis conditions. Given expressions use only the total background at the place of gamma-ray photopeak and the Full Width at Half Maximum (FWHM) for this peak. The main parameters occurring in these limits are studied and some recommendations are given. The use of these limits in some expressions of radioactivity analysis results (single measure, sum, mean) is also indicated.

32970 (CNIC–00236) **Some factors affecting the accuracy of uranium content determined by DNC measurement.** Song Quanxun (Academia Sinica, Beijing, BJ (China). Inst. of Atomic Energy). China Nuclear Information Centre, Beijing, BJ (China). 1988. 6p. (In Chinese). (IAE–0048). Order Number DE90626916. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Some factors affecting the accuracy of uranium contents determined by delayed neutron counting and methods solving these problems are described. One of the factors is deterioration of the BF_3 proportional counters. This problem is discussed in more detail.

32971 (DESY-F–35-90-01) **Development of a precise hadron calorimeter.** Dierks, K. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.); Hamburg Univ. (Germany, F.R.). Fachbereich Physik. Jan 1990. 79p. (In German). Order Number DE90785070. Available from NTIS (US Sales Only), PC A05/MF A01.

For the Zeus detector, which is presently under construction, a prototype of the forward calorimeter was built and its performance was investigated. All measurements were performed with the test beams of the accelerators PS and SPS at CERN in Geneva. Hadrons, electrons and muons were available in an energy range from 0.5 to 100 GeV. The calorimeter prototype consists of 16 towers with 20 cm x 20 cm cross-section. Each tower is longitudinally segmented in an electromagnetic section with 25 cm length and two hadronic sections, each with 63 cm length. All towers are built from plates of depleted uranium of 3.3. mm thickness and scintillator plates with 2.6 mm thickness. In previous measurements these values were determined to be the best choice in order to obtain the best energy resolution. The light readout was performed by wavelength shifters (PMMA, doped with Y-7) and photomultiplier tubes. Some important results of these measurements are: The design energy resolution 35%/$\sqrt{E}$+2% for hadrons and 18%/$\sqrt{E}$+2% for electrons has been achieved. The e/h-ratio was determined to be 1.00±0.01. The linearity of the calorimeter was found to be better than 2% in the investigated energy range. The nonuniformity of the wavelength shifter was improved to be better than 2% by reflectors with absorbing patterns printed on it. The deviations from uniformity at the boundaries between calorimeter modules were reduced to 7% by insertion of lead sheets in the gap. A big advantage was the possibility to use the natural radioactivity of the uranium for calibration purposes. (orig.)

32972 (DESY-F–35-90-02) **Behaviour of the ZEUS uranium-scintillator calorimeter for low-energetic particles with energies of 0.2 - 10.0 GeV.** Fuertjes, A. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.); Muenster Univ. (Germany, F.R.). Fachbereich 16 - Physik. Feb 1990. 103p. (In German). Order Number DE90792339. Available from NTIS (US Sales Only), PC A06/MF A01.

A prototype for the high-resolution calorimeter (FCAL) of the ZEUS detector was tested at a test beam of the CERN PS for beam momenta between 0.5 GeV/c and 10.0 GeV/c. The response of the calorimeter to low-energetic electrons, positrons, pions of both polarities, and protons should be studied. Additionally the effect of dead matter in front of the calorimeter was experimentally studied. Following results could be determined: Electrons and Positrons of equal energy produce comparable signals in the detector. Their response is in the considered momentum range with an accuracy of below 1% linear. The energy resolution of the calorimeter for electrons and positrons in the studied energy interval amounts to 17.5%/$\sqrt{E}$. The response of the calorimeter to π^+ and π^- is similar down to momenta of 0.5 GeV/c. The e/π ratio reaches the value 1.0 for energies above 2 GeV. For small incident energies e/mip=0.62 result. The energy resolution for pions amounts for energies above 2 GeV about 34%/$\sqrt{E}$. For smaller particle energies improvements can be observed. Protons show an identical behaviour as the pions, if the interesting quantities are considered in dependence on their kinetic energy. Dead matter in the front of the calorimeter influences the particle signals of low-energetic positrons and pions. The pulse-height spectra of electrons remain symmetric, but shift to small values. This behaviour could be confirmed by Monte-Carlo calculations. Pions show a distribution becoming with increasing matter density more asymmetric. At energies up to 2 GeV a significant effect mean values, energy resolution, and e/h ratio can be recognized. Above 2 GeV no important nuisance of the response to positrons and pions can yet be observed. (orig.).

32973 (EGG–10617-2066) **Gabor zone plate apertures for imaging with the mercuric iodide gamma ray camera.** Patt, B.E. (EG and G Energy Measurements, Inc., Goleta, CA (USA)); Meyyappan, A.; Cai, A.; Wade, G. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-88NV10617. (CONF-900563–6: 7. symposium on radiation measurements and applications, Ann Arbor, MI (USA), 21-24 May 1990). Order Number DE90011193. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Gabor zone plate (GZP) apertures have been developed for use in EG&G EM's mercuric iodide (H_gI_2) gamma-ray camera. The purpose of such an aperture is to increase efficiency, while maintaining good resolution. The GZP is similar to the Fresnel zone plate (FZP) but it has continuous transitions between opaque and transparent regions. Because there are no sharp transitions in the transmission the inherent interference noise in GZP imaging is lower than that in FZP imaging. GZP parameters were chosen by considering the effects of constraints such as detector pixel size, number of pixels, minimum field of view required, maximum angle of incidence tolerated, and the Nyquist criterion for the minimum sampling rate. As a result an aperture was designed and fabricated with eight zones and a diameter of 3 cm. Lead was chosen as the aperture medium due to its high attenuation coefficient. Experimental data were obtained from the camera with the above GZP

aperture. The point-spread function was determined and compared to the calculated response. Excellent agreement was obtained. The reconstruction process involves simulating, by computer, planar-wave illumination of a scaled transparency of the image and recording the intensity pattern at the focal plane. 6 refs., 7 figs.

32974 .:(EGG-M-89295) **Rapid determination of plutonium content on filters and smears using Alpha Liquid Scintillation.** Shaw, P.G. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 22p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-891082-3: International conference on new trends in liquid scintillation counting and organic scintillators, Gatlinburg, TN (USA), 2-5 Oct 1989). Order Number DE90010987. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper discusses a technique for rapidly determining plutonium content on filters and smears using Alpha Liquid Scintillation. Filter and smear samples will be analyzed daily for plutonium (Pu^{239}) content during projected waste retrieval operations at the Radioactive Waste Management Complex (RWMC) of the Idaho National Engineering Laboratory. daily monitoring will allow for trending of airborne and surface contamination. Alpha Liquid Scintillation (ALS) in conjunction with microwave digestion was investigated as a technique for rapid Pu analyses. Advantages offered by ALS are short turnaround time and field use with acceptable accuracy. A state-of-the-art Photon Electron Rejecting Alpha Liquid Scintillation (PERALS) Spectrometer utilizing pulse shape discrimination (PSD), and on oil filled photomultiplier tube counting chamber with 99.7% counting efficiency and 99.95% rejection of beta and gamma pulses, was used. Relatively clean filter samples could be directly counted in an all purpose scintillant, bis 2-ethylhexyl phosphoric acid (HDEHP), 4-biphenyl-6-phenylbenzoxazole (PBBO), toluene and naphthalene. Laboratory preparation of soil samples and smears with high inert solids content was accomplished by dissolution of the sample in nitric and hydrofluoric acids using a microwave digestion system in teflon pressure vessels. The Pu in the dissolved sample was extracted into tertiary amine nitrate and counted in a HDEHP or 1-nonyldecylamine sulfate (NDAS) containing extractive scintillant. This method is applicable to the determination of total plutonium in air filters, smears and soils. 9 refs., 8 figs., 5 tabs.

32975 (KFK-4671) **Simulation of the build-up phase of a high voltage low pressure gas discharge using Monte-Carlo-methods.** Niessen, W. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Karlsruhe Univ. (T.H.) (Germany, F.R.). Fakultaet fuer Physik. Feb 1990. 87p. (In German). Order Number DE90792215. Available from NTIS (US Sales Only), PC A05/MF A01.

In this report the simulation of a Pseudospark predischarge between anode and cathode using Monte-Carlo-Methods is described. In the early phase of the discharge electric and magnetic self-fields can be neglected. The model is based on a discharge between two infinitely extended capacitor plates. Eleven different collision reactions and two electrode surface effects are taken into account. A Fortran program was developed that computes the built-up of the discharge in time and space. A specially of the code is, that not only electrons and ions are taken into account, but also fast neutral atoms and molecules. Three pairs of diode-length and voltage were investigated at different pressures: 350 kV/5.0 cm, 30 kV/10.0 cm and 6.9 kV/0.7 cm. The working gas was hydrogen. The computations included: The Paschen-curve, the time evolution of the current densities of the electrons at the anode and the ions at the cathode, the space- and time-dependent particle densities, the time-dependent energy distributions of the different particle species, the relative number of the different collision reactions. (orig./HSI).

32976 (KURRI-TR-318, pp. 11-17) **4π SI ball.** Nakaya, R. (Kyushu Univ., Fukuoka (Japan). Faculty of Science); Mukai, Junko; Min, B.J.; Maeda, Toyokazu; Mitarai, Shiro; Kuroyanagi, T. Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. May 1989. (In Japanese). (CONF-8901177-: 1. specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor, Kumatori (Japan), 24-25 Jan 1989). In *Proceedings of the 1st specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor.* Order Number DE90741373. Available from NTIS (US Sales Only), PC A06/MF A01.

The report addresses the developement of a 4π-type Si detector array, called Si crystal ball, designed for determination of the multiplicity of charged particles. The design requirements for the detector array are as follows: it should be possible to distinguish between output signals for proton and α particle; the detector system as a whole should be operable up to a counting rate of about 5×10^5 cps; the vacuum tank containing the detector array and target should be of a size that permits its accommodation in a spherical container with a diameter of 98 mm; the detector system should have a dodecahedron configuration consisting of pentagonal unit detectors; and the incident particles should not enter the detector system to allow heavy ions to damage the system. Each pentagonal unit detector has sides of 18 mm and a thickness of 178 μm. Tests are made to determine the performance of the Si crystal ball. Results show that its detection efficiency is 25 percent for 3p-channel gamma rays gated by 3p and 40 percent for 2p-channel gamma rays gated by 2p, which are about 20 and 10 times as high, respectively, compared to conventional detectors. (N.K.).

32977 (LBL-28836) **Measurements of 1/f noise in A-Si:H pin diodes and thin-film-transistors.** Cho, Gyuseong (Lawrence Berkeley Lab., CA (USA)); Drewery, J.S.; Fujieda, I.; Jing, T.; Kaplan, S.N.; Perez-Mendez, V.; Qureshi, S.; Wildermuth, D.; Street, R.A. Lawrence Berkeley Lab., CA (USA). May 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900466-41: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90011218. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We measured the equivalent noise charge of a-Si:H pin diodes ($5 \sim 45\mu$m i-layer) with a pulse shaping time of 2.5 μsec under reverse biases up to 30 V/μm and analyzed it as a four component noise source. The frequency spectra of 1/f noise on the soft-breakdown region and of the Nyquist noise from contact resistance of diodes were measured. Using the conversion equations for a CR-RC shaper, we identified the contact resistance noise and the 1/f noise as the main noise sources in the low bias and high bias regions respectively. The 1/f noise of a-Si:H TFTs with channel length of 15 μm was measured to be the dominant component up to ~100kHz for both saturation and linear regions. 15 refs., 7 figs.

32978 (SLAC-PUB-5214) **Electrostatic design of the barrel CRID [Cherenkov Ring Imaging Detector] and associated measurements.** Abe, K. (Tohoku Univ., Sendai (Japan). Dept. of Physics); Hasegawa, K.; Suekane, F.; Yuta, H.; Antilogus, P.; Aston, D.; Bienz, T.; Bird, F.; Dunwoodie, W.; Hallewell, G. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Apr 1990. 10p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract AC03-76SF00515. Grant PHY88-13669;Grant PHY88-13018. (CONF-9003150-3: 5. international conference on instrumentation for colliding beam physics, Novosibirsk (USSR), 15-21 Mar 1990). Order Number DE90010182. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We report on the electrostatic design and related measurements of the barrel Cherenkov Ring Imaging Detector for the Stanford Large Detector experiment at the Stanford Linear Accelerator Center Linear Collider. We include test results of photon feedback in TMAE-laden gas, distortion measurements in the drift boxes and corona measurements. 13 refs., 21 figs.

32979 (UCRL-101659) **Multiframe x-ray images from a single meander stripline coated on a microchannel plate.** Bell, P.M. (Lawrence Livermore National Lab., CA (USA)); Kilkenny, J.D.; Power, G.; Bonner, R.; Bradley, D.K. Lawrence Livermore National Lab., CA (USA). Aug 1989. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890836-24: 33. SPIE annual international technical symposium on optical and optoelectronic applied science and engineering, San Diego, CA (USA), 6-11 Aug 1989). Order Number DE90010741. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The electrical gating of microchannel plates can produce shutter times shorter than 100 ps. Previously, several different micro strip lines with independent electrical gating have been coated on a microchannel plate in order to obtain several image areas on one microchannel plate. We describe here design considerations and

results from a microstrip line coated as a meander on a microchannel plate, from which 14, 100 ps images, gated at different times are obtained from a single gate. 5 refs., 5 figs.

32980 (UCRL-ID–103470) **Altitude-velocity envelope for a moving neutron detector.** McAllister, S.W.; Johnson, R.K. Lawrence Livermore National Lab., CA (USA). Mar 1990. 21p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010285. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report shows the relationship between neutron detector velocity and closest point of approach (CPA) based on an operational criteria of a probability of false alarm (P_{fa}) < 0.01 and a probability of missed target (P_{mt}) < 0.02. The neutron detector analyzed is a xylene based scintillator with a photomultiplier tube. 6 refs., 11 figs.

32981 Application of Fabry-Perot velocimeter to high-speed experiments. Chaw, H.H. (Lawrence Livermore National Lab., Livermore, CA (US)); McMillan, C.F.; Osher, J.E. 540-546 of Proceedings of the 18th international congress on high speed photography and photonics. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). DOE Contract W-7405-ENG-48. (CONF-8808103–: 18. international congress on high-speed photography and photonics, Xian (China), 28 Aug - 2 sep 1988).

The Fabry-Perot (F-P) velocimeter is a useful instrument for measuring the velocity of objects at speeds ranging from fractions of a kilometer per second to a few tens of kilometers per second and up. Because of its immunity to electromagnetic interference and its velocity resolution, it has become the prime diagnostic tool in our electric-gun facility. Examples of its application to high speed experiments are discussed, including: electric-gun flyer studies, spallation of materials under high-speed impact, momentum-transfer studies, pressure pulse created by high-velocity impact, and detonation-wave studies in high-explosive experiments.

32982 Efficient energy spectrometer for charged particle detection in surface studies. Mayer, R. (Department of Physics, Brookhaven National Laboratory, Upton, New York 11973 (US)); Becker, D.; Schwab, A.; Weiss, A. *Review of Scientific Instruments (USA),* 61(1): 42-48 (Jan 1990). DOE Contract AC02-76CH00016.

We have recently built a spectrometer that efficiently collects the energy spectrum of charged particles that emerge from targets bombarded by low-flux (10^{-15} A) incident beams. The spectrometer is used to detect positron-induced secondary electrons and low-energy positron-stimulated Auger electron emission. Slow positrons and positron-induced secondary electrons are generated from a cold neon positron moderator deposited onto an encapsulated ^{22}Na source. The moderated beam is magnetically transported to the target with two sets of $E \times B$ plates. The particles emerging from the target are energy dispersed by a third set of plates and are detected with a one-dimensional position-sensitive detector. The data-collection rate for the energy-distribution spectrum is ~10–100 times faster for this experiment relative to the more common method of sweeping grids or the plates.

32983 Group fellowship training in nuclear spectroscopy instrumentation maintenance at the Seibersdorf Laboratories. Xie, Y. (International Atomic Energy Agency, Seibersdorf (Austria). Laboratories); Abdel-Rassoul, A.A. *International Atomic Energy Agency Bulletin (Austria),* 31(4): 61-63 (1989).

Nuclear spectroscopy instruments are important tools for nuclear research and applications. Several types of nuclear spectrometers are being sent to numerous laboratories in developing countries through technical co-operation projects. These are mostly sophisticated systems based on different radiation detectors, analogue and digital circuitry. In most cases, they use microprocessor or computer techniques involving software and hardware. Maintenance service and repair of these systems is a major problem in many developing countries because suppliers do not set up service stations. The Agency's Laboratories at Seibersdorf started conducting group fellowship training on nuclear spectroscopy instrumentation maintenance in 1987. This article describes the training programme.

32984 A cell for extended x-ray absorption fine structure studies of oxygen sensitive products of redox reactions. Furenlid, L.R. (Department of Applied Science, Brookhaven National Laboratory, Upton, New York 11973 (USA)); Renner, M.W.; Fajer, J. *Review of Scientific Instruments (USA),* 61(4): 1326-1327 (Apr 1990). DOE Contract AC02-76CH00016.

We describe a cell suitable for extended x-ray absorption fine structure (EXAFS) studies of oxygen and/or water sensitive products of redox reactions. The cell utilizes aluminized Mylar windows that are transparent to x rays, provide low gas permeability, and allow vacuum to be maintained in the cell. The windows are attached to the glassware with an epoxy that resists attack by common organic solvents. Additional side arms allow multiple spectroscopic probes of the same sample under anaerobic and anhydrous conditions.

4402 Radiation Effects on Instrument Components, Instruments, or Electronic Systems

Refer also to citation(s) 32966, 32967

32985 (SAND–90-0344C) **Thermal emission model for the anneal of radiation-induced trapped holes.** McWhorter, P.J.; Miller, S.L.; Miller, W.M. Sandia National Labs., Albuquerque, NM (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900723–7: 27. IEEE annual international nuclear and space radiation effects conference, Reno, NV (USA), 16-20 Jul 1990). Order Number DE90007285. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We find that the anneal of trapped holes can be predicted through the use of a first order thermal emission model. This model allows accurate prediction of long term hole anneal from short term laboratory measurements. 9 refs., 5 figs.

32986 (SAND–90-0367C) **Total-dose degradation of thin film ferroelectric capacitors.** Schwank, J.R.; Miller, S.L.; Nasby, R.D.; Rodgers, M.S.; Dressendorfer, P.V. Sandia National Labs., Albuquerque, NM (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900723–3: 27. IEEE annual international nuclear and space radiation effects conference, Reno, NV (USA), 16-20 Jul 1990). Order Number DE90007152. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The effects of total-dose irradiation on $PbO\text{-}ZrO_2\text{-}TiO_2$ ferroelectric capacitors have been studied in detail. It is shown that significant total-dose degradation of ferroelectrics can occur at dose levels greater than 1 Mrad(Si). 6 refs., 5 figs.

32987 (SAND–90-0410C) **1/f noise in irradiated MOS devices.** Meisenheimer, T.L.; Jones, R.V.; Fleetwood, D.M. Sandia National Labs., Albuquerque, NM (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900723–6: 27. IEEE annual international nuclear and space radiation effects conference, Reno, NV (USA), 16-20 Jul 1990). Order Number DE90007288. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The 1/f noise of MOS transistors has been measured as a function of total ionizing dose and postirradiation biased annealing time. Comparison to oxide and interface trapped-charge buildup and annealing is discussed. 13 refs., 3 figs.

32988 (SAND–90-0501C) **Radiation hardening of a high voltage IC technology (BCDMOS).** Desko, J.C. Jr. (AT and T Bell Labs., Reading, PA (USA)); Darwish, M.N.; Dolly, M.C.; Goodwin, C.A.; Dawes, W.R. Jr.; Titus, J.L. Sandia National Labs., Albuquerque, NM (USA). [1990]. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900723–11: 27. IEEE annual international nuclear and space radiation effects conference, Reno, NV (USA), 16-20 Jul 1990). Order Number DE90008345. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

PIC's (Power Integrated Circuits) are becoming increasingly important because they allow integration of high-voltage and high-current power transistors, precision linear control circuitry, and low-voltage logic gates on the same monolithic chip. Integration of power and control functions provide benefits in reduced weight and size, enhanced reliability, and lower costs over conventional

designs using these same components packaged separately. However, commercial PIC technologies, including AT&T's commercial BCDMOS technology, are susceptible to failure in radiation environments. The relative lack of radiation hardness of the AT&T BCDMOS technology was previously reported at this conference. Radiation hardening of PIC technologies is significantly more difficult than for other IC technologies, primarily because of the integration of many different types of devices into the technology. To facilitate integration, different devices share processing sequences. Thus, no one device can be optimized independently of the remaining devices. Since each device has its own distinct radiation response, this adds another set of constraints on the optimization of the overall technology from the point of view of device performance and radiation response. The high-voltage requirements further complicates efforts to harden a PIC technology. Modifying one device to optimize one aspect of its performance can severely impact all the other devices in the technology. 4 refs., 5 figs.

4405 Thermal Instrumentation

Refer also to citation(s) 32732

32989 (LBL–28885) **Fabrication of a high T_c superconducting bolometer.** Verghese, S. (California Univ., Berkeley, CA (USA). Dept. of Physics); Richards, P.L.; Char, K.; Sachtjen, S.A. Lawrence Berkeley Lab., CA (USA). Apr 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-9004105–1: Superconductivity applications for infrared and microwave devices, Orlando, FL (USA), 16-20 Apr 1990). Order Number DE90011306. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A sensitive high $T_c$superconducting bolometer has been fabricated with a YBCO thin film thermometer on a 20 μm thick sapphire substrate. Electrical measurements showed no noticeable film degradation after bolometer fabrication. Optical measurements gave a noise equivalent power of $5 \cdot 10^{-11}$ W/Hz $^{\frac{1}{2}}$ at 10 Hz and a responsivity of 22 V/W. This performance is comparable to that of the very best pyroelectric detectors. Significant improvement appears possible. 4 refs., 3 figs.

32990 **Theoretical considerations on the hot-wire method applied to solids under pressure.** Pettersson, S. (Solid State Division, Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, Tennessee 37831-6030 (USA)— Department of Physics and Astronomy, University of Tennessee, Knoxville, Tennessee 37996-1200 (USA)). *Review of Scientific Instruments (USA),* 61(4): 1308-1313 (Apr 1990). DOE Contract AC05-84OR21400.

We have examined the theory behind the hot-wire method for determining the thermal conductivity and heat capacity of solids under pressure. Temperature corrections due to finite thermal conductivity of the wire are large but do not influence the determination of the thermal properties of the surrounding solid. The three coupled heat equations for the wire, medium, and the cell wall have been solved and we find that the wall effects are small. The most important correction comes from the temperature dependence of the thermal properties of the solids and it can explain part of the errors observed in experiments.

4406 Optical Instrumentation

Refer also to citation(s) 32635, 32709, 32732, 32844, 33730, 33762

32991 (EGG-M–89360) **A convenient system for diffraction moire measurements.** Deason, V.A.; Ward, M.B. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 10p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-8908128–2: Western Regional Strain Gage Committee meeting, Idaho Falls, ID (USA), 22 Aug 1989). Order Number DE90010980. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This device utilizes single mode polarization maintaining optical fibers to generate the pair of laser beams required by diffraction moire interferometry. Design of the device permits extremely rapid and convenient setup for measurement of in-plane displacement distributions on the surfaces of specimens. The device, applications, and typical data are described.

32992 (EGG-M–90027) **Automatic, high-resolution analysis of low-noise fringes.** Lassahn, G.D. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC07-76ID01570. (CONF-900756–1: SPIE's international symposium on optical and optoelectronic applied science and engineering and exhibit, San Diego, CA (USA), 8-13 Jul 1990). Order Number DE90009779. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We outline a fringe analysis algorithm that is completely automatic and has been demonstrated to give individual pixel resolution with good accuracy for very general types of fringe patterns, but is slow and quite sensitive to noise in the raw fringe image. 1 fig.

32993 (SAND–89-8253) **Interferometric second-harmonic-generation autocorrelator for characterizing femtosecond pulses.** Kuska, M. Sandia National Labs., Livermore, CA (USA). Nov 1989. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90010331. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We discuss an interferometric second-harmonic-generation (SHG) autocorrelator for characterizing femtosecond pulses generated by a colliding-pulse, mode-locked ring dye laser. The autocorrelator consists of a modified Michelson interferometer. One arm provides a variable time delay through the use of a corner cube oscillating at 60 Hz. Electronic filters are used to display the pulse envelope and the second-harmonic interference fringes. Since this autocorrelator produces an interferometric autocorrelation signal, it is possible to monitor the effects of pulse chirping, as well as the pulse width. 5 refs., 7 figs.

32994 **The chemistry and physics of nonlinear optical materials: A new look at an old field.** Velsko, S.P. (Lawrence Livermore National Lab., Livermore, CA (US)); Eimerl, D. 287-287 of Optical materials. Poker, D.B.; Ortiz, C. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-8904283–: Optical materials: processing and science, San Diego, CA (USA), 24-26 Apr 1989).

Recent efforts to engineer new nonlinear optical materials with specific desired characteristics has engendered a need for a theoretical description of optical properties which is readily accessible to chemists, yet correctly treats the essential physics of dielectric response. This paper describes a simple empirical molecular orbital model which gives useful insights into the relationship between chemical composition, crystalline structure, and optical susceptibilities. The authors compare the probabilities of finding new harmonic generators in various chemical classes. Rigorous bounds on the magnitudes of linear and nonlinear optical coefficients and their anisotropies are also discussed.

32995 **Ion implantation of Ti into $LiNbO_3$: Fabrication of waveguides and simple modulators.** White, C.W. (Solid State Div., Oak Ridge National Lab., Oak Ridge, TN (US)); Thomas, D.K.; Ashley, P.R.; Chang, W.S.C.; Buchal, C. 294-298 of Optical materials. Poker, D.B.; Ortiz, C. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-8904283–: Optical materials: processing and science, San Diego, CA (USA), 24-26 Apr 1989).

Ion implantation has been used to introduce Ti at very high doses ($\geq$ 3 (multi) 10^{17}/cm ^{2}) into the near-surface region of $LiNbO_3$ to change the index of refraction. In the as-implanted state, the near surface is amorphous. Thermal annealing in water-saturated oxygen at 1000°C crystallizes the amorphous region and incorporates the Ti into substitutional sites in the lattice at concentrations that excess 10 at . %. Recrystallization takes place by solid-phase epitaxy. Both planar and channel waveguides have been fabricated with optical attenuations of < 1 dB/cm. Both Mach-Zehnder and Bradgg modulators have been fabricated using Ti implantation of $LiNbO_3$. The characteristics of these devices have been determined and are reported. The higher Ti concentrations which can be achieved by implantation allows tighter mode confinement and smaller mode profiles than with Ti-diffused guides.

32996 **Soliton-collision interferometer for the quantum nondemolition measurement of photon number: numerical results.** Sakai, Y. (Basic Research Laboratories, Nippon Telegraph,

Musashino-shi, Tokyo 180 (Japan)); Hawkins, R.J.; Friberg, S.R. *Optics Letters (USA)*, 15(4): 239-241 (15 Feb 1990).

Using analytic theory and numerical experiments, we show that a quantum nondemolition measurement of the photon number of optical solitons in a single-mode optical fiber can be made. We describe the soliton-collision interferometer with which we propose to make this measurement and discuss simulations of the performance of this interferometer.

32997 Measurements of Smith–Purcell radiation. Shih, I. (Hughes Aircraft Company, Support Systems, P.O. Box 9399, Long Beach, California 90810-0399 (US)); Salisbury, W.; Masters, D.; Chang, D. *Journal of the Optical Society of America, Part B: Optical Physics (USA)*, 7(3): 345-350 (Mar 1990).

We present experimental results on Smith–Purcell radiation. Our primary interest was in the measurement of radiation angular distribution, output power, and spectral content. The variations of the angular distribution and the output power were shown for different electron-beam voltages and currents. The output power measured with a 3-mA and 120-kV electron beam was $\sim 30\ \mu W/cm^2$-sr. The spectral analysis of the radiation shows excellent agreement between the measurements and the theoretical predictions. Our results were compared with those obtained by Gover et al. [J. Opt. Soc. Am. B 1, 723 (1984)].

32998 Two-channel polarization modulation ellipsometer. Jellison, G.E. Jr. (Oak Ridge National Laboratory, P.O. Box 2008, Solid State Division, Oak Ridge, Tennessee 37831-6056 (USA)); Modine, F.A. *Applied Optics (USA)*, 29(7): 959-974 (1 Mar 1990). DOE Contract AC05-84OR21400.

A new wavelength-scanning two-channel polarization modulation ellipsometer is described, where a photoelastic modulator is used and the analyzed light is separated into orthogonally polarized beams using a Wollaston prism. Both beams are detected using phototubes whose bias voltage is dynamically controlled for constant dc. The dc from each phototube is measured with a digital voltmeter, and the fundamental and second harmonic of the phototube current are measured using individual lock-in amplifiers. All three of the associated ellipsometric parameters ($N = \cos 2\psi$, $S = \sin 2\psi \sin\Delta$, and $C = \sin 2\psi \cos\Delta$) can be determined simultaneously in a single scan. The versatility of the instrument is demonstrated by the determination of the optical functions of Si from 238 to 652 nm (5.3–1.9 eV).

32999 High-power Nd:glass laser transmission through optical fibers and its use in acceleration of thin foil targets. Trott, W.M. (Sandia National Laboratories, Albuquerque, New Mexico 87185 (USA)); Meeks, K.D. *Journal of Applied Physics (USA)*, 67(7): 3297-3301 (1 Apr 1990). DOE Contract AC04-76DP00789.

Measurements on commercially available fused silica fibers and fiber tapers have shown that Nd:glass laser pulses of irradiance >3.5 GW cm^{-2} can be transmitted without bulk or surface damage. Optical energy at the fiber output can be used for efficient acceleration of thin metal foils. For 0.025-mm-thick aluminum coupled to a 0.2-mm-diam fiber, target foil velocities up to 2.3 km s^{-1} have been achieved with very modest laser energies (<25 mJ).

4407 Geophysical and Meteorological Instrumentation

Refer also to citation(s) 33058

33000 (SAND–89-2658) **Aerosol Dynamics Laboratory.** Rader, D.J.; Mondy, L.A. Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 23p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90010275. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In past five years, Department 1510 has developed a state-of-the-art Aerosol Dynamics Laboratory (ADL). This report documents the current instrumentation and capabilities that exist in this laboratory. The ADL was developed from a variety of sources, with a primary contribution from Department 1510's Independent Research and Development program in aerosol dynamics. Current capabilities of the ADL include: (1) generation of calibration-quality monodisperse particles with diameters between 0.005 to 100 μm, (2) real-time measurement of particle size distributions for particle diameters between 0.01 and 100 μm, (3) in situ, real-time measurement of particle size distributions for particle diameters between 0.3 and 100 μm, and (4) real-time measurement of particle charge distributions for particle diameters between 0.01 and 1.0 μm. 14 refs., 5 figs.

33001 (UCRL-CR–103263) **SDA/LARS™ final report: Development and verification of a learning and recognition system (LARStrademark) for seismic data analysis (SDA).** Lawrence Livermore National Lab., CA (USA); GTE Government Systems Corp., Needham Heights, MA (USA). Command, Control and Communications Systems Div. 29 Dec 1989. 43p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010695. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

GTE was contracted by Lawrence Livermore National Laboratory (LLNL) to develop a demonstration prototype Learning and Recognition System (LARS™) for Seismic Data Analysis (SDA). The primary goal of this effort was to determine the applicability of neural networks in solving seismic data analysis problems. The neural networks were designed and trained using GTE's proprietary Learning and Recognition System (LARS™). This final report describes the design of this Prototype SDA/LARS™ System and how well it performed in analyzing the limited available data. Two different approaches were used in attacking the problem. The first approach consisted of using a single network (called a three-waveform neural network), which has as its input the three preprocessed waveforms (Pn, Pg, and Lg), concatenated to form a single input array. The second approach consisted of training one network for each of the waveforms (each of which is called a one-waveform neural network) plus another network to fuse the results of the three networks. 2 refs., 7 figs., 2 tabs.

4408 Miscellaneous Instrumentation

Refer also to citation(s) 32088, 32114, 32163, 32261, 32628, 32636, 32742, 32792, 32795, 32874, 32883, 33023, 33050, 33060, 33119, 33196, 33199, 33213

33002 (ALS/TR–90-008) **Method of fabricating an oxide-aluminum humidity sensor.** Fridzon, M.B. (Tsentral'naya Aerologicheskaya Observatoriya, Dolgoprudnyy (USSR)); Balagurogv, A.M.; Patrushev, Yu.N.; Petukhov, A.B. Sandia National Labs., Albuquerque, NM (USA). 23 Mar 1990. 7p. Translation of USSR Patent Specification No. 667,932, June 15, 1979. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90011046. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This invention relates to measuring technology and is intended for the fabrication of oxide-aluminum sensors for the humidity of gases, in particular air, said sensors to be employed in meteorology and also in other sectors of the national economy, for example in the chemical industry, medicine, and agriculture.

33003 (CBPF-NT–001/89) **S100 lathe bed pulse generator applied to pulsed nuclear magnetic resonance.** Cernicchiaro, G.R.C.; Rudge, M.G.; Albuquerque, M.P. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 32p. (In Portuguese). Order Number DE90628279. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The project and construction of four channel pulse generator in the S100 standard plate and its control software for microcomputer are described. The microcomputer has total control on the pulse generator, which has seven programable parameters, defining the position of four pulses and the width for the three first ones. This pulse generator is controlled by a software developed in c language, and is used in pulsed nuclear magnetic resonance experiences. (M.C.K.).

33004 (CBPF-NT–004/89) **Apple interface for experimental instrumentation and control-Pulse counter, timer, digital-to-analog converter, step motor and relays.** Souza, J.H.; Cernicchiaro, G.R.C.; Cavalcante, J.T.P.D. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 17p. (In Portuguese). Order Number DE90628280. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

An interface plate for Apple II type microcomputer developed aiming to automatize measuring systems in which a TTL pulse counter, output of analogic voltage (with resolution of 12 bits), out put of step-motor control, relay drive, and timer for real time control, are necessary to carry-out the parallel tasks, is described. An application of this plate to a thermoluminescence reader is also presented. (M.C.K.).

33005 (DOE/CE/15444–T2) **Development of the oil-water monitor: Quarterly progress report No. 3.** Swanson, C. Applied Physics Technology, Inc., Great Falls, VA (USA). 2 Apr 1990. 6p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-89CE15444. Order Number DE90010522. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The oil-water monitor is a device invented by Dr. Claude Swanson of Applied Physics Technology to respond to the petroleum-loss problem in crude oil transfers. It is a device which measures water content in crude oil and other petroleum products, in a flowing pipe such as a pipeline or tanker manifold. It is capable of accurately measuring the water contamination levels in crude oil shipments, in real time as the crude oil flows through the loading manifold into the tanker, or at the receiving point as the oil is off-loaded It has application in the verification of oil volumes and concentration of contaminants at petroleum transfer points. The industry-estimated level of water loss at transfer points due to inadequate monitoring technology amounts to several billion dollars per year, so there is a definite perceived need within the petroleum community for this type of accurate water monitoring technology. The device has been patented, and initial feasibility experiments have been conducted. The present research is directed toward developing and demonstrating a bench model prototype of the oil-water monitor, complete with the computer software and automated microwave equipment and electronics which will demonstrate the performance of the invention, for implementation in full-scale fielded systems. 3 figs.

33006 (IC–89/421) **Failure analysis of leakage current in plastic encapsulated packages.** Hu, S.J. (International Centre for Theoretical Physics, Trieste (Italy)); Cheang, F.T. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 11p. Order Number DE90628281. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Plastic encapsulated packages exhibit high leakage current after a few hundred hours steam pressure pot test. The present study investigates two possible sources of leakage current, the mold compound and the lead frame tape used for taping the lead frame fingers. The results of the study indicate that the leakage current is independent of the frame and is not caused by the mold compound. The data further indicates that it is the ionic contents and acrylic-based adhesive layer of the lead frame tapes which cause the leakage current. To eliminate the leakage current, lead frame tape with low ionic contents and non acrylic-based adhesive should be used. (author). 1 fig., 2 tabs, 3 graphs.

33007 (PB–90-184417/XAB) **Real-time bit-wear estimation using surface-vibration signals. Phase 1.** Ekchian, L. OPTIMA Systems, Inc., Burlington, MA (USA). Apr 1987. 47p. Available from NTIS, PC A03/MF A01.

This research investigated the feasibility of monitoring in real time the condition of an oil-well drill bit, based solely on surface-vibration data. The problem of extracting the desired information on the bit from surface-vibration data is complex. Surface data are heavily masked with corruptive noise due to the extremely noisy environment on the rigs, dynamics of the drill string inside the borehole, attenuation of the vibration signal propagating up the drill string, and unknown lithology, which varies as one drills. Modern estimation theory concepts were introduced to study this stochastic problem and formulate a real-time, bit-wear-estimation methodology.

33008 (SAND–89-0126C) **Utilization of polymer viscoelastic properties in acoustic wave sensor applications.** Martin, S.J.; Ricco, A.J.; Frye, G.C. Sandia National Labs., Albuquerque, NM (USA). [1990]. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9006171–1: Solid state sensor and actuator workshop, Hilton Head Island, SC (USA), 4-7 Jun 1990). Order Number DE90010534. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The changes which occur in polymer viscoelasitc properties in response to cross-linking reactions and due to absorption of gas phase species have been used advatageously in several acoustic wave-based sensor applications. When a polymer film is present on the surface of an acoustic wave device, changes in the visoelastic properties of the film induce changes in wave porpagation velocity and attenuation, providing two sensor responses. Film changes which occur polymer cross-linking allow photopolymerization to be monitored in real time using acoustic devices. A photoaction spectrum of photoresist reveals the cross-linking wavelength with maximum quantum yield. Changes in the viscoelastic properties of a polysiloxane film induces by vapor absorption are found to be unique for each of several species, enabling differentiation of species with a single film. A Maxwell model for polymer viscoelasticity, in combination with mass loading effects, provides a sound theoretical basis for explaining observed results for both polysiloxane and polybytadiene/polystyrene copolymer films. 16 refs., 5 figs.

33009 (SAND–90-0164C) **Flash x-ray measurements with a time projection Compton spectrometer.** Baldwin, G.T.; Landron, C.O.; Lee, J.R.; Leeper, R.J.; Lorence, L.J. Jr. Sandia National Labs., Albuquerque, NM (USA). [1990]. 30p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900563–5: 7. symposium on radiation measurements and applications, Ann Arbor, MI (USA), 21-24 May 1990). Order Number DE90011050. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We have developed a "Time Projection Compton Spectrometer" (TPCS) to measure the time-integrated photon energy spectrum between 0.1 and 2 MeV of short-pulse, intense bremsstrahlung sources. A target in the TPCS produces Compton electrons when illuminated by the flash X-ray source. Target electrons are trapped magnetically by current in a rod on the axis of an evacuated drift tube. The curvature and gradient of magnetic field cause the electrons to drift parallel to the spectrometer axis. Time of electron arrival at the end of a 1-m drift encodes the energy spectrum of the X-ray burst. The detector is a plastic scintillator coupled to a fast photomultiplier tube. Despite heavy shielding, enough prompt X-rays penetrate to give a time fiducial. Background is measured on shots with the X-ray target removed. The response of the TPCS is calculated using the TIGERP computer code to model photon/electron transport in the target and a sophisticated algorithm to compute electron drift velocity. The response functions and signal are the known components of a matrix equation, which is solved to determine the unknown spectrum. We tested the TPCS with flash X-ray sources on the Saturn accelerator. Signals have been analyzed, spectra unfolded, and results compared with other methods. 14 refs., 12 figs.

33010 **Influence of support gas composition on glow discharge properties.** Niemczyk, T.M. (New Mexico Univ., Albuquerque, NM (USA). Dept. of Chemistry); Angus, J.E.; Palmer, B.A.; Layman, L.R. 1-1 of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 687.

The hollow cathode lamp, which is an example of a glow discharge source, has found wide application, especially as the source in atomic absorption experiments. More recently, glow discharge lamps have been shown to be useful atomic emission sources for the analysis of solid samples. Generally the discharge is supported by a low pressure of a noble gas (Ar or Ne). The authors present the results of a study in which the support gas in a glow discharge was altered from pure Ar or Ne to one containing a small percentage of nitrogen. The results obtained upon introduction of a small percentage of nitrogen include an enhancement of overall line intensity, a change in the intensity pattern (i.e., some lines enhanced more than others), and some line broadening. The most dramatic effect is the intensity enhancement of selected lines.

The addition of nitrogen to the support gas adds additional excitation pathways. The intensity enhancement and its selective nature can be explained as being the result of analyte collisions with excited state nitrogen molecules. The line broadening could be the result of several different effects. In an attempt to understand this phenomenon, a series of experiments have been performed using an ultra high resolution Fourier transform spectrometer to measure the line shapes of the mixed gas glow discharge lamps. These studies are compared to a series of flow-tube experiments using nitrogen as the excitation gas. The flow tube experiments allow the study of the excitation mechanisms due to the nitrogen without the complication of the glow discharge. These results are used to aid in the explanation of the line broadening seen in the mixed gas glow discharge sources.

33011 Quality control and the use of reference materials in an environmental laboratory. Gladney, E.S. (Los Alamos National Lab., NM (USA)). 1-1 of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 1164.

The analytical chemistry activities in the Health and Environmental Chemistry Group at an environmental laboratory are diverse and encompass environmental, industrial hygiene, human bioassay, human tissue, industrial waste-water, and compliance areas. One of the fundamental responsibilities of management is to maintain a continuing quality assurance (QA) program to ensure the accuracy, reliability, and validity of analytical laboratory data. This program addresses small, single investigator projects (in which one person conducts all sampling, analytical, and interpretive functions) through large-scale facilities monitoring programs requiring year-to-year continuity. The authors' philosophy is that a QA program should apply to all aspects of sample and information management, beginning at the conception of a project and extending through interpretation and final publication of results.

33012 The Berkeley atomic resolution microscope: An update. Hetherington, C.J.D. (National Center for Electron Microscopy, Lawrence Berkeley Lab., Univ. of California, 1 Cyclotron Rd., Berkeley, CA (US)); Nelson, E.C.; Westmacott, K.H.; Gronsky, R.; Thomas, G. 277-282 of High resolution microscopy of materials. Krakow, W.; Ponce, F.A.; Smith, D.J. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC03-76SF00098. (CONF-8811196–: MRS symposium on high resolution microscopy of materials, Boston, MA (USA), 29 Nov - 1 dec 1988).

Recent modifications to the JEOL ARM-1000 microscope have markedly enhanced its performance. The point resolution limit at 1000 kV is confirmed by optical diffractograms down to 1.7Å and there are firm indications of contrast transfer down to 1.4Å. The unique tilting capability of the ARM, ± 40° biaxial tilt over the 800 kV to 1000 kV range, is preserved at this resolution. This paper presents the measured imaging parameters and results of resolution tests.

33013 High-Speed Microphotographic Laboratory. Frank, A.M. (B-Division (L-368), Lawrence Livermore National Lab., Livermore, CA (US)). 1026-1037 of Proceedings of the 18th international congress on high speed photography and photonics. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). DOE Contract W-7405-ENG-48. (CONF-8808103–: 18. international congress on high-speed photography and photonics, Xian (China), 28 Aug - 2 sep 1988).

Lawrence Livermore National Laboratory's (LLNL's) High-Speed Microphotographic Laboratory is discussed. It provides a facility for studying rapidly evolving microstructures. In particular, the exploding of wires and foils and their interactions with high explosives are of particular interest. The facility combines high-speed electronic framing and streak cameras with the appropriate specialized optics, spectographs, and laser illumination to record events with a few nanoseconds and micrometers of temporal and spatial resolutions, respectively. Velocity and spectral data are also used to compute pressures with better than kilobar resolution.

33014 A multipurpose miniature diamond anvil cell. Sterer, E. (School of Physics— School of Astronomy, Tel Aviv University, 69978 Ramat Aviv, Israel (IL)); Pasternak, M.P.; Taylor, R.D. *Review of Scientific Instruments (USA)*, 61(3): 1117-1119 (Mar 1990).

A new multipurpose miniature diamond anvil high-pressure cell (DAC) has been constructed. The circular DAC has an overall 22-mm diam. and 15-mm height and is comprised of a gasket, opposing diamond anvils each mounted on backing plates, and force rings (platens). The pressure is generated by six Allen-type screws. Pressures up to 38 GPa were achieved with this miniature cell. Design features, mode of operation, and performance are described. A particular application to cryogenic and room temperature ^{119}Sn Moessbauer spectroscopy is presented.

45 MILITARY TECHNOLOGY, WEAPONRY, AND NATIONAL DEFENSE

Refer also to citation(s) 32496

33015 (PB–90-185687/XAB) **Defense Nuclear Agency (DNA). Directive.** Furtner, R. Office of the Secretary of Defense (Administration and Management), Washington, DC (USA). 18 Mar 1987. 11p. (DOD-D–5105.31). Available from NTIS, PC A03/MF A01.

Under the authority vested in the Secretary of Defense by Title 10, United States Code, the Directive reissues DoD Directive 5105.31, November 3, 1971, to update the responsibilities, functions, relationship, and authorities of the Defense Nuclear Agency.

33016 (PB–90-186511/XAB) **Laser-guidance systems, security classification. Instruction.** Flickinger, A. Office of the Deputy Under Secretary of Defense for Policy, Washington, DC (USA). 3 Dec 1982. 13p. (DOD-I–5210.62). Available from NTIS, PC A03/MF A01.

The Instruction reissues Department of Defense (DoD) Instruction 5210.62, April 25, 1980, and prescribes policies, standards, and criteria governing the security classification of information pertaining to any laser-guidance system that is developed in whole or in part with information or knowledge obtained from or developed for the Department of Defense; and provides guidance to DoD Components responsible for issuing security classification guides for individual systems and equipment under their control.

33017 (PB–90-186529/XAB) **Security classification of information concerning high-energy lasers. Instruction.** MacCallum, J. Office of the Under Secretary of Defense (Acquisition), Washington, DC (USA). 18 Sep 1981. 14p. (DOD-I–5210.61). Available from NTIS, PC A03/MF A01.

The Instruction reissues Department of Defense (DoD) Instruction 5210.61, April 7, 1977, to update policy and guidance, and establishes uniform criteria for the security classification of information concerning DoD programs and projects involving the research, development, test and evaluation (RDT&E), application, production, and operational use of high-energy lasers (HEL), and their application for military purposes, whether as weapons or in other military systems.

33018 (PB–90-186966/XAB) **Military Liaison Committee to the Department of Energy. Directive.** Reid, J. Assistant Secretary of Defense (Atomic Energy), Washington, DC (USA). 24 Jan 1979. 5p. (DOD-D–5148.1). Available from NTIS, PC A01/MF A01.

The Directive reissues DoD Directive 5148.1, January 7, 1959, to redefine the functions and authority of the Military Liaison Committee and the relationship of the Committee with the Office of the Secretary of Defense, the Military Departments, the Organization of the Joint Chiefs of Staff, and the Defense Agencies and with the Department of Energy. The Directive implements section 27 of the Atomic Energy Act of 1954 as amended, Title 42, United States Code 2037(1976), which establishes the Military Liaison Committee.

33019 (PB–90-188970/XAB) **Nuclear Weapon Personnel-Reliability Program. Directive.** Pike, R. Office of the Deputy Under Secretary of Defense for Policy, Washington, DC (USA). 6

Dec 1985. 22p. (DOD-D-5210.42). Available from NTIS, PC A03/MF A01.

The Directive reissues DoD Directive 5210.42, April 23, 1981, to update policy governing the Nuclear Weapon Personnel Reliability Program. The program is designed to ensure the highest possible standards of individual reliability in personnel performing duties associated with nuclear weapons and nuclear components.

33020 (PB-90-189218/XAB) **Counterintelligence and operations security-support program for the Defense Nuclear Agency. Directive.** Nelson, L. Office of the Deputy Under Secretary of Defense for Policy, Washington, DC (USA). 25 Jan 1983. 6p. (DOD-D-5240.3). Available from NTIS, PC A02/MF A01.

The Directive establishes the counterintelligence (CI) and operations security (OPSEC) support program for the Defense Nuclear Agency which includes activities designed to protect classified and operationally sensitive unclassified information and material. Included are CI investigations, counterespionage and countersabotage operations, OPSEC analyses, technical surveillance countermeasures services, CI security education, and CI security assistance.

33021 (SAND-87-0959) **The prediction of loads on penetrators into rock via the spherical cavity expansion approximation.** Longcope, D.B. Jr. Sandia National Labs., Albuquerque, NM (USA). May 1990. 31p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90010323. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A spherical cavity expansion (SCE) model for axial loads on penetrators into rock has been developed and used in the GNOME penetrator code to calculate a recent full-scale strategic earth penetrator test (SEPW) into sidewinder tuff. The 2-D target motion is approximated by the 1-D motion produced by an expanding spherical cavity which allows rapid calculations over a complete penetrator trajectory. The target response includes a region of tensile fracturing which has not been modeled in production continuum dynamics code calculations. One reason for the development of this model is the current interest in blunter nosed penetrators than those previously analyzed with cylindrical cavity expansion (CCE) load models. 12 refs., 7 figs.

33022 (SAND-90-8216) **A user's guide to the SCABBARD scenario language: Edition 2.** Rogers, J.N.; Tooman, T.P. Sandia National Labs., Livermore, CA (USA). May 1990. 101p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DR00789. Order Number DE90010327. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

SCABBARD is a discrete event simulation wargame that portrays battlefield actions in a corps area of operation. The model addresses deep battle features such as mobility, logistics, and force interdiction. Current studies have addressed the military effectiveness of differing nuclear weapons, division rear area traffic, the mission effectiveness of conventional artillery munitions, and targeting strategies. This document is a user's manual for SCABBARD scenario language, which is the means that the analyst uses to direct the military actions the model simulates.

33023 **Explosives detection using an atmospheric sampling glow discharge ionization source with an ion trap mass spectrometer.** Grant, B.C. (Oak Ridge National Lab., TN (USA). Analytical Chemistry Div. (USA)); McLuckey, S.A.; Glish, G.L. 1-1 of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-890331--: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 1092.

The authors have adapted the atmospheric sampling glow discharge ionization (ASGDI) source to a Finnigan ion trap mass spectrometer (ITMS) and have evaluated the potential of this device as the mass spectrometry/mass spectrometry (MS/MS) instrument of an explosives detector. According to the authors the ITMS has several features that make it potentially more useful as the MS/MS device for an explosives detector relative to beam-type tandem mass spectrometers such as the quadrupole/time-of-flight instrument. For example, the ITMS is relatively small, rugged, and very flexible in its operation. Furthermore, since it is a trapping device, transmission losses normally associated with beam-type instruments can be avoided. The MS/MS efficiency is therefore much greater in the ITMS than in beam-type instruments. A key to the use of the ITMS for explosives detection, however, lies in the efficiency with which ions can be injected into the trap from the ASGDI source. Collision induced dissociation and electron detachment occur upon ion injection. Under the appropriate conditions, these phenomena can compromise the use of the ASGDI source/ITMS combination as an explosives detector. The authors find, however, that they can be minimized by applying relatively low radio frequency voltage levels to the ring electrode during injection and using a light bath gas, such as hydrogen or helium, at a pressure of a few milliTorr.

4501 Chemical Explosions and Explosives

Refer also to citation(s) 32806, 32871, 33039

33024 (AD-A-217161/9/XAB) **Condensed-phase kinetic deuterium isotope effects in high-energy phenomena: Mechanistic investigations and relationships. Technical report, January 1975-December 1989.** Shackelford, S.A. Frank J. Seiler Research Lab., United States Air Force Academy, CO (USA). Dec 1989. 52p. (FJSRL-TR-89-0010). Available from NTIS, PC A04/MF A01.

The rate-controlling mechanistic step of an energetic material's condensed phase thermochemical decomposition process is determined directly using the kinetic deuterium isotope effect (KDIE) approach. The KDIE is used with isothermal DSC and isothermal TGA analyses of TNT, HNBB, TATB, RDX, HMX, and their deuterium labeled analogs. The decomposition processes' rate-controlling step possibly can change as the energetic material physical state varies. The condensed phase KDIE approach that determines the rate-controlling mechanistic step in a slow thermochemical decomposition process, can be extended into the progressively more drastic high energy regimes encountered with the rapid pyrolytic decomposition/deflagration process, plus the higher temperature/pressure combustion, thermal explosion, and detonation events. The KDIE determined mechanistic relationships between the slow thermochemical decomposition process and more hostile high energy events are individually described for HMX, RDX, TATB, and TNT.

33025 (SAND-90-0001C) **A transformer coupled semiconductor bridge igniter for low voltage ignition from a high voltage source.** Bickes, R.W. Jr.; Schlobohm, S.L. Sandia National Labs., Albuquerque, NM (USA). [1990]. 9p. Sponsored by U.S. Department of Defense. DOE Contract AC04-76DP00789. (CONF-900792--1: 15. international pyrotechnics seminar, Boulder, CO (USA), 9-13 Jul 1990). Order Number DE90009974. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Some missile systems have high voltage, short (< 1 μs) current pulses available for ignition of the missile's rocket motor. Such high voltage systems are desirable for enhanced safety considerations. However, application of high voltage firing pulses to conventional 1-Ω bridgewire igniters can result in a detonation in the igniter rather than a well controlled burn. We present in this paper a concept proposed by Eglin Air Force Base for converting the high voltage (2 kV) firing signal pulse to the appropriate low voltage (<50 V) and low energy (approximately 1.5 mJ) input required for semiconductor bridge, SCB, igniters. The Eglin concept makes use of a pot core transformer to step down the input voltage. Our transformer Ferroxcube pot core (10 mil air gap) with a 50-turn primary and 1-turn secondary. In our prototype design, the 1-turn secondary is a Kapton-laminated copper loop with the SCB directly bonded to the ends of the copper loop. The igniter assembly consist of the primary spool and secondary loop mounted in the pot core transformer with a hole, which serves as the charge holder for the igniter material, drilled in one of the pot core halves and positioned directly over the SCB. The igniter material is pressed into the charge holder against the SCB. Application of a 2 kV (<1 μs) pulse to the primary, produces a 40-V signal in the secondary that functions the SCB and ignites the explosive material. In addition to

the 2-kV all-fire ignition requirement, the ignition system must be able to withstand 500-V no-fire signals and electrostatic discharge, ESD, inputs. We will discuss in this paper various design configurations of this component and their output and also the ability of this concept to successfully withstand the no-fire and ESD inputs. 7 refs., 5 figs., 1 tab.

33026 (SAND–90-0125C) **Aerosol cloud generation experiments.** Ratzel, A.C.; Constantineau, E.J. Sandia National Labs., Albuquerque, NM (USA). [1990]. 20p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900792–4: 15. international pyrotechnics seminar, Boulder, CO (USA), 9-13 Jul 1990). Order Number DE90011051. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper provides results from an experimental study performed to evaluate the use of homogeneous and granulated explosive mixture concepts for creating spherical aerosol clouds. In the explosive mixture concept, a small mass of explosive is added to a larger mass of fine inert particulate, and the blend is hand-tamped into a confining cylindrical or spherical structure thereby creating a bed of explosive mixture. The mixture proportions are selected such that the mixture is able to sustain a reaction, be it a detonation or deflagration, throughout the bed. This approach generates gas for aerosol dispersal throughout the bed rather than from the center of the bed (as from a center-driven concept device). As such, a uniformly dispersed aerosol, rather than a thin shell of aerosol, would be expected to be dispersed. The two mixture concepts considered in this work differed only in the assembly and blending of the inert and explosive. Of interest in this work was the evaluation of the explosive mixture concepts relative to providing uniform spherical clouds of fine oxide aerosols of characteristic dimension less than 10 um. Programmatic constraints dictated that the mass and quantity of extraneous materials such as the external structure and other peripherals associated with initiation also be minimized. Experiments were conducted in air with spherical devices ranging in size from 3" to 15" in diameter and with cylindrical and conical shotgun devices of length 4" to 7". The latter test were performed to assess reaction sustainability for different explosive mixture ratios. Trends obtained from the studies as well as an assessment of the explosive mixture dispersal concept are included. 7 refs., 15 figs.

33027 (SAND–90-0388) **Graphical analysis of barrel-tamped explosively accelerated flyer plates.** Vigil, M.G. Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 41p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90010299. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Analytical equations for barrel-tamped explosively accelerated flyer plates are used to generate graphical solutions to flyer problems. Given the problem geometrical dimensions, explosive weight, detonation velocity, explosive exponent, barrel-tamping weight, and flyer weight, the graphical representation of the calculated data allows for a fast approximation of the final or maximum flyer plate velocity. Graphically obtained flyer velocities are compared to experimentally published data. The graphical solution for flyer velocity is particularly useful when a computer is not available. The graphical representation of the various barrel-tamped flyer parameters results in a parametric study which illustrates the effect on final flyer velocity in varying parameters. The graphical analysis scheme can be used with any explosive, tamper and flyer materials. 15 refs., 12 figs., 4 tabs.

33028 (SAND–90-0577C) **Modeling laser ignition of explosives and pyrotechnics: Effects and characterization of radiative transfer.** Skocypec, R.D.; Mahoney, A.R.; Glass, M.W.; Jungst, R.G.; Evans, N.A.; Erickson, K.L. Sandia National Labs., Albuquerque, NM (USA). [1990]. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900792–5: 15. international pyrotechnics seminar, Boulder, CO (USA), 9-13 Jul 1990). Order Number DE90011052. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The ignition of explosives and pyrotechnics using commercial diode lasers has been demonstrated and is of interest as a potential replacement for hot-wire ignition. Initial laser diode ignitor (LDI) test results using the detonation-to-deflagration transition(DDT) explosive CP (2-(5-cyanotetrazolato) pentaamminecobalt (III) perchlorate, $C_2H_{15}N_{10}Co–Cl_2O_8$) doped with carbon black and graphite have reinforced the need for a better understanding of the interaction of the radiant energy transfer within the pressed material. The present work is directed toward developing a model to predict the transfer of laser energy in the pressed particulate charges. It is shown here that scattering can have a major effect on the volumetric absorption of laser energy, significantly affecting the thermal response of the granular energetic material. This paper describes an effort to characterize the radiative properties of compacted granular beds of CP and CP doped with carbon black or graphite that were prepared using normal pressing techniques. Current estimates of the radiative properties are presented and indicate dramatic in absorption for CP when even a minute amount of carbon black or graphite is added. Initial data indicate pressed, undoped CP scatters radiative energy significantly. The radiative properties are dependent upon both wavelength and packing density; the less-densely packed samples exhibit more scattering. Doped samples exhibit essentially wavelength-independent characteristics. 14 refs., 7 figs., 1 tab.

33029 (UCRL–102393) **The search for high energy low vulnerability explosives.** Holtz, E. von; Scribner, K.; Moody, G.; McGuire, R. Lawrence Livermore National Lab., CA (USA). 13 Mar 1990. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900712–2: 21. international conference of the Fraunhofer-Institut fuer Chemische Technologie: technology of polymer compounds and energetic materials, Karlsruhe (Germany, F.R.), 3-6 Jul 1990). Order Number DE90009436. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Lawrence Livermore National Laboratory (LLNL) is currently attempting to formulate explosives which have approximately 30% greater energy than our current TATB/Kel-F explosive, while still passing the Department of Energy's (DOE) Insensitive High Explosive (IHE) criteria. The new formulations are comprised of HMX, TATB, and high density fluoropolymers and fluoroplasticizers. Variables in the study include the particle size of HMX, type of TATB (wet or dry aminated), the ratios of polymers to plasticizers, and formulation techniques. Initial small scale sensitivity tests and thermal testing have shown promising results. This paper will relate the up-to-date status of the project. 5 refs., 2 tabs.

33030 (UCRL–102395) **Development of a high-tensile-strain plastic-bonded TATB explosive.** Pruneda, C.; McGuire, R.; Clements, R. Lawrence Livermore National Lab., CA (USA). 5 Apr 1990. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900712–3: 21. international conference of the Fraunhofer-Institut fuer Chemische Technologie: technology of polymer compounds and energetic materials, Karlsruhe (Germany, F.R.), 3-6 Jul 1990). Order Number DE90011463. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Typical plastic-bonded explosives (PBX) with greater than 90 weight-percent explosive filler in a fluorocarbon binder have tensile strains which range from 0.2 to 0.6%. We have recently developed a TATB-based PBX with a tensile strain approaching 1% while maintaining a high-volume loading of the crystalline explosive component. We discuss our formulation efforts to design a TATB/poly[styrene-(ethylene-butylene)-styrene](Kraton)[1] PBX and the critical processing parameters which affect the ultimate mechanical properties of this PBX. 9 refs., 3 figs., 5 tabs.

33031 (UCRL–102578) **Burning mechanism and regression rate of RX-35-AU and RX-35-AV as a function of HMX particle size measured by the hybrid closed bomb-strand burner.** Tao, W.C.; Costantino, M.S.; Ornellas, D.L. Lawrence Livermore National Lab., CA (USA). Apr 1990. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9004147–5: 1990 JANNAF propulsion systems hazards meeting, Laurel, MD (USA), 3-5 Apr 1990). Order Number DE90010677. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In this study, the average surface regression rate of two HMX-based cast explosives, RX-35-AU and RX-35-AV, is measured to pressures above 750 MPa using a hybrid closed bomb-strand burner. The hybrid design allows the simultaneous measurement of pressure and regression rate over a large range of pressures in each experiment. Nitroglycerin/Triacetin (75/25) and polyethylene

glycol (PEG) are used as the energetic plasticizer and polymeric binder, respectively, in both formulations. The HMX solids loading in each formulation is 50 wt %, consisting of a narrow particle size distribution of 6–8 μm for RX-35-AU and 150–177 μm for RX-35-AV. Of special interest are the regression rate and burning mechanism as a function of the initial particle size distribution and the mechanical properties fo the cast explosives. In general, the regression rate for the larger particle size formulation, RX-35-AV, is two to three times faster compared to that for RX-35-AU. Up to 750 MPa and independent of the initial confinement pressure, RX-35-AU exhibits a planar burning mechanism with the regression rate obeying the classical aP^n formalism. For RX-35-AV, however, the burning behavior is erratic for samples ignited at 200 MPa confinement pressure. At confinement pressures above 400 MPa, the regression exhibits more of a planar burning mechanism. The unstable combustion behavior for RX-35-AV at lower confinement pressures is related to several mechanisms: (1) an abrupt increase in surface area due to particle fracture and subsequent translation and rotation, resulting in debonding and creating porosity, (2) "thixotropic" separation of the binder and nitramine, causing the significantly greater fracture damage to the nitramine during the loading cycle, (3) microscopic damage to the nitramine crystals that increase its intrinsic burning rate. 12 refs., 8 figs., 2 tabs.

33032 (UCRL-JC–103244) **Paste extrudable explosives: Their history and their current status.** von Holtz, E.; Scribner, K.; Whipple, R.; Carley, J. Lawrence Livermore National Lab., CA (USA). 13 Mar 1990. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900712–1: 21. international conference of the Fraunhofer-Institut fuer Chemische Technologie: technology of polymer compounds and energetic materials, Karlsruhe (Germany, F.R.), 3-6 Jul 1990). Order Number DE90009438. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Lawrence Livermore National Laboratory (LLNL) has a continuing effort in the development of Paste Extrudable Explosives (PEX) for use in high performance munitions. Upon request, the paste could be injected into place just prior to warhead launch, giving enhanced safety during transport, storage, and deployment. The desire for high energy (greater than Comp B) required the development of an energetic plasticizer which would not freeze in the range of –54 to +74C, and yet be compatible with the desired crystalline explosive. These materials are highly viscous and extremely pseudoplastic in nature. Extensive rheological testing has been done, using a capillary rheometer, and the behavior has been fit to power law (Ostwald-deWaele) and Buckingham-Reiner models. This report will also cover the safety testing conducted on these materials, as well as the processing techniques required for their manufacture. 9 refs., 6 figs., 5 tabs.

33033 (UCRL-JC–103512) **Modeling jet penetration in glass.** Glenn, L.A.; Moran, B.; Kusubov, A.S. Lawrence Livermore National Lab., CA (USA). 5 Apr 1990. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9005122–2: 1990 conference on the application of 3-D hydrocodes to armor/anti-armor problems, Aberdeen Proving Ground, MD (USA), 7-11 May 1990). Order Number DE90010683. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

It is well known that composite armors, consisting of glass elements confined with metallic tampers, are extraordinarily effective against shaped charge attack. Early experiments showed that jets fired against glass targets appeared to be bombarded by tiny fragments that destroyed alignment and reduced residual jet penetration. This result was attributed to an elastic rebound effect in which the outward radial motion of the target around the jet periphery was supposed to be arrested by tensile hoop stresses which developed behind the divergent shock front. Glass fragments were then accelerated radially inward and these destabilized the jet. To sustain the large tensile hoop stresses required, the glass must not have been fractured by the initial shock, behind which the stress state is typically well above the Hugoniot elastic limit. Modeling the penetration of a jet into glass requires not only determining the spall strength, i.e., the tensile stress at which fracture is first initiated, but also the subsequent response of the material. An important aspect of this response is the dilatancy accompanying fracture. Dynamic experiments have shown that glass can bulk as much as 20% or more impact loading. When confined by metallic tampers, the dilatancy is associated with a significant residual stress in the fractured glass. This paper describes a phenomenological model that has been proposed. 10 refs., 3 figs.

33034 (UCRL-JC–103626) **Sensor fusion methodology for remote detection of buried land mines.** Del Grande, N. Lawrence Livermore National Lab., CA (USA). Apr 1990. 20p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9004188–1: 3. national symposium on sensor fusion, Orlando, FL (USA), 16-20 Apr 1990). Order Number DE90010633. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We are investigation a sensor fusion methodology for remote detection of buried land mines. Our primary approach is sensor infrafusion. Our dual-channel passive IR methodology decouples true (corrected) surface temperature variations of 0.2°C from spatially dependent surface emissivity noise. It produces surface temperature maps showing patterns of conducted heat from buried objects which heat and cool differently from their surroundings. Our methodology exploits Planck's radiation law. It produces separate maps of surface emissivity variations which allow us to reduce false alarms. Our secondary approach is sensor interfusion using other methodologies. For example, an active IR CO_2 laser reflectance channel helps distinguish surface targets unrelated to buried land mines at night when photographic methods are ineffective. Also, the interfusion of ground penetrating radar provides depth information for confirming the site of buried objects. Together with EG&G in Las Vegas, we flew a mission at Nellis AFB using the Daedalus dual-channel (5 and 10 micron) IR scanner mounted on a helicopter platform at an elevation of 60 m above the desert sand. We detected surface temperature patterns associated with buried (inert) land mines covered by as much as 10 cm of dry sand. The respective spatial, spectral, thermal, emissivity and temporal signatures associated with buried targets differed from those associated with surface vegetation, rocks and manmade objects. Our results were consistent with predictions based on the annual Temperature Wave Model.They were confirmed by field measurements. The dual-channel sensor fusion methodology is expected to enhance the capabilities of the military and industrial community for standoff mine detection. Other important potential applications are open skies, drug traffic control and environmental restoration at waste burial sites. 11 figs.

4502 Nuclear Explosions and Explosives

Refer also to citation(s) 32881, 33108

33035 (DOE/NV–317) **Radiological effluents released from announced US continental tests, 1961 through 1988.** Schoengold, C.R.; DeMarre, M.E.; McDowell, E.M. Reynolds Electrical and Engineering Co., Inc., Las Vegas, NV (USA). Technical Information Dept. May 1990. 191p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-89NV10630. Order Number DE90011243. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

This report documents all announced continental tests from September 15, 1961 through December 12, 1988, from which radioactive effluent was released. General information listed for each event includes the date, location, type of test, sponsoring laboratory and/or agency, purpose, yield range, extent of the release, and type of release. A summary of each release incident by type of release is included. For an event-time release, the effluent curies are expressed at R+12 hours; for controlled releases from tunnel events, the effluent curies are expressed at both time of release and at R+12 hours, if available. All other types are listed at the time of the release. A qualitative statement of the isotopes in the effluent is included for event-time and controlled releases, and a quantitative listing is included for all other types. Offsite release information includes the cloud direction, maximum activity detected in the air offsite, maximum gamma exposure rate detected offsite, maximum iodine level detected offsite, and maximum distance radiation was detected offsite. A final summary includes whatever

other pertinent information was available for the release(s) associated with each event. This document includes effluent release information for 313 events, only 52 of which were detected offsite.

33036 (SAND–90-0519) **Numerical modeling tools for transient electromagnetic problems.** Riley, D.J.; Turner, C.D.; Bacon, L.D.; Kotulski, J.D. Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 163p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC04-76DP00789. Order Number DE90010328. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Finite-difference time-domain (FDTD) codes can, in principle, be used to determine the electromagnetic response of complex scatterers. However, the extent to which structural details can be accommodated is limited by computer resources and one's ability to specify necessary parameters. By embedding into the FDTD code alternative numerical methods that solve the aspects of the problem which are not practical, or possible, for the FDTD code to handle, power and flexibility can be added. This report investigates three such hybrid schemes. Topics include: (1) embedding a transient multiconductor/circuit-analysis code so that coupling down to the component level can be directly computed; (2) the effectiveness of using a multiconductor transmission-line code to analyze shielded multiwire cables in FDTD calculations; and (3) the effectiveness of using two– and three– dimensional aperture transfer functions to model narrow apertures in FDTD formulations. These topics were selected because of their immediate need in system assessments. Experimental measurements and/or alternative solution methods are used to verify the hybrid approaches. 56 figs.

33037 (UCRL–21239) **Design of a gun system for in-situ compressive strength measurements.** Lynch, C.S. (Dynasen, Inc., Goleta, CA (USA)); Charest, J.A. Lawrence Livermore National Lab., CA (USA); Dynasen, Inc., Goleta, CA (USA). Nov 1989. 59p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008783. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report summarizes a six-month effort aimed at developing concepts and preliminary designs of a remotely operated gun system that can be lowered into a main emplacement hole. The gun will perform penetration tests which produce in-situ compressive strength data for the geological materials surrounding a nuclear device. Such information is needed to support the modeling of the containments of nuclear explosions. 2 refs., 18 figs., 2 tabs.

33038 (UCRL-ID–103766) **DOE requirements for the next generation controller.** Patterson, S.R. (Lawrence Livermore National Lab., CA (USA)); Gross, V.E.; Williams, T.L. Lawrence Livermore National Lab., CA (USA). 27 Apr 1990. 41p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010288. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Department of Energy nuclear weapons complex relies heavily on manufacturing automation to provide a cost effective source of high quality, reliable weapons systems components. This document describes requirements within the DOE for an advanced real time controller. This controller is anticipated to satisfy complex developmental requirements for machine tool, measuring machine and robot controllers. The requirements emphasize open architecture and general purpose, versatile software tools. The requirements detail the underlying hardware and software structures. A variety of potential applications are also discussed in order clarify the required versatility of acceptable designs. 22 refs.

33039 (UCRL-JC–103498) **Analysis of explosions in hard rocks: The power of discrete element modeling.** Heuze, F.E.; Walton, O.R.; Maddix, D.M.; Shaffer, R.J.; Butkovich, T.R. Lawrence Livermore National Lab., CA (USA). Mar 1990. 68p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9004171–3: International conference on mechanics of jointed and faulted rocks, Vienna (Austria), 18-20 Apr 1990). Order Number DE90010689. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This paper describes developments and applications of the discrete element (DE) method of analysis, for a better understanding of the effects of explosions in hard rocks. These rock formations are known to be penetrated by geological discontinuities such as joint sets, faults, shears, etc. For example, granite, dolomite, hard limestones and sandstones, and gneiss belong in that category. We start by illustrating, through field and laboratory results, the considerable influence that the joints and faults can have on the propagation of ground shock and on the resulting motions. We then contrast the shortcomings of the continuum-based methods such as finite differences and finite elements with the potential of discrete elements, for analyzing the dynamics of jointed media. We introduce the DE method through a description of essential features of the LLNL DIBS (Discrete Interacting Block Systems) two-dimensional model. In particular, we emphasize such aspects as normal and shear deformation laws for block contacts, coefficient of restitution, treatment of the boundaries for wave propagation, and damping. We also describe the DE calculation process. We then apply the DIBS code to the simulation of high explosive (HE) and nuclear events, both near-surface and contained.

4503 Nuclear Explosion Detection

Refer also to citation(s) 32529, 33001

4504 Nuclear and Radiological Warfare

Refer also to citation(s) 33044

4505 Strategic Defense Initiative

Refer also to citation(s) 32881

33040 (LA–11743-MS) **Exchange ratios for singlet boost-phase defenders.** Canavan, G.H. Los Alamos National Lab., NM (USA). May 1990. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90010263. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Decreasing singlet defender masses could increase exchange ratios by a factor of about 1.5; decreasing overhead could increase exchange ratios by a factor of about 2. Reducing both could increase exchange ratios by factors of 3–7, which would allow highly decoyed singlets to approach ideal limits and singlets with even tens of decoys to achieve significant survivability. 5 refs., 5 figs.

33041 (LA–11776-MS) **Onboard detection of intrinsic Lyα radiation from a neutral particle beam.** Robiscoe, R.T. (Montana State Univ., Bozeman, MT (USA). Dept. of Physics); Cobb, D.D.; Maier, W.B. II. Los Alamos National Lab., NM (USA). May 1990. 27p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90010341. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We consider photometers onboard a hydrogen neutral particle beam (NPB) space platform which monitor the instrinsic radiation from excited atoms in the NPB in flight. The radiation of choice is the Lyman α (Lyα) line 1216 A, emitted when the beam's $\simeq$ 7% fraction of H (2S) atoms is motionally quenched in the earth's magnetic field. At nominal 20-MeV NPB energy, the Lyα radiation persists at 1% of its initial intensity out to 100 m along the beam, and is red-shifted to 1494 A when viewed form behind the exciting NPB pulse. A photosensitive detector with a $\sim$ 5° field of view, placed adjacent to the NPB exit port and viewing the NPB pulse along its limb, shows marked changes in detected Lyα intensity when the NPB axis shifts direction. If the NPB pulse is nominally 50 MA times 100 μs, and if the detector is a 1-cm^2 array of 25 μm times 25 μm photosensitive pixels located in the focal plane of an 8-cm diam. f/1 LiF lens, then pixels at the brightest part of the beam image are illuminated by up to 2300 Lyα photons per NPB pulse. The pixel quantum efficiency, optics transmission losses, and a geometric correction for viewing angle reduce the maximum count rate to $\sim$ 200 photoelectrons per pixel per pulse under realistic operating conditions, and at a limb-viewing angle (i.e., angle between beam and detector axes) of $\simeq$ 6 mrad. At smaller viewing angles the pixels count rate declines rapidly, but rapidly, but becomes sensitive to small angular shifts in the NPB axis direction. In the limit of shot-noise on the pixel count, and at optimum viewing

angle ($\simeq$ 0.54 mrad), we find that a single pixel can sense beam-axis shifts of $\simeq \pm 50$ μrad. 8 refs., 7 figs., 2 tabs.

33042 (SAND–90-0161C) **Predicting switched-bias response from steady-state irradiations.** Fleetwood, D.M. Sandia National Labs., Albuquerque, NM (USA). [1990]. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900723–2: 27. IEEE annual international nuclear and space radiation effects conference, Reno, NV (USA), 16-20 Jul 1990). Order Number DE90006770. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In actual circuit application, MOS transistor bias is generally not constant through radiation exposure. Nevertheless, the overwhelming majority of radiation effects studies and hardness assurance testing is performed at constant bias for simplicity and practicality. In the past 15 years, however, it has been shown that oxide- and interface-trap charge buildup and annealing during switched-bias exposures can differ quantitatively and qualitatively from that observed during steady-state exposures. This has made it difficult to develop predictive models of MOS circuit response for actual use conditions, and has introduced uncertainty into hardness assurance testing of MOS circuits. In this summary, defect growth and annealing rates are compared for steady-state and switched-biased irradiations of MOS transistors. A simple method is described to predict MOS oxide-trap charge, interface-trap charge, and mobility degradation during switched-bias exposures from steady-state ("on" and "off") irradiations. Over a wide range of switching conditions for the devices examined, this method has provided predictions typically accurate to within better than 20%. The maximum error observed to data is less than 40%. This method should allow the total-dose radiation response of MOS circuits in real-use scenarios to be modeled with improved accuracy and flexibility. 9 refs., 3 figs.

33043 (SAND–90-0226C) **A new technique for hardening optically-triggered thyristors.** Carson, R.F.; Hughes, R.C.; Weaver, H.T.; Brennan, T.M.; Hammons, B.E. Sandia National Labs., Albuquerque, NM (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900723–1: 27. IEEE annual international nuclear and space radiation effects conference, Reno, NV (USA), 16-20 Jul 1990). Order Number DE90006769. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Optically-triggered thyristors are hardened to high x-ray dose rates by the addition of a monolithically integrated compensating photodetector. Tests of discrete device arrangements show radiation-induced switching is completely inhibited up to 1.4×10^9 rad (Si)/sec. 1 ref., 4 figs.

33044 (UCRL–101292) **Brilliant pebbles.** Wood, L.; Scott, W. Lawrence Livermore National Lab., CA (USA). Jun 1989. 20p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CONF-8906320–1: Strategic defense initiative technical achievements symposium, Washington, DC (USA), 29-30 Jun 1989). Order Number DE90010756. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A strategic defense system is sketched which consists of nothing more then a set of identical, highly capable, small spacecraft deployed in low Earth orbit and tasked with interdicting via hypervelocity collision ballistic missiles and their components in flight under human command and control. The member spacecraft of such a defensive constellation may each be equipped with the functional analogs of eyes, mouths, brains and legs capable of detecting and hunting down advanced ballistic missiles over distances of thousands of kilometers without external aid or guidance, yet may have a size and weight comparable to that of a pubescent child. Interestingly enough, these Brilliant Pebbles–highly intelligent but sharply scaled-down Smart Rocks–can be implemented with contemporary American technology for a deployed cost of much less than a million dollars each, and less than 10,000 of them appear likely to offer a robust, stand-alone strategic defense capability, including the possibility of adaptive preferential defense. Supporting Government test and evaluation of this concept through realistic but Treaty-compliant in-space exercise is the principal focus of the program for the next two years. Other major national security-supporting applications of the Brilliant Pebbles technology, such as Brilliant Eyes, are briefly surveyed. 8 figs.

4506 Chemical and Biological

33045 (PB–90-863762/XAB) **Chemical and biological warfare: Defoliants and herbicides. January 1970-March 1990 (A Bibliography from the NTIS data base). Report for January 1970-March 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 145p. Available from NTISPC N01/MF N01.

Supersedes PB–89-859946.

This bibliography contains citations concerning the use of defoliants as chemical warfare agents. The studies relate to effectiveness of such agents and their use in South Vietnam, and government policies relating to use and disposal of defoliants. Included are research studies conducted by the Veterans Administration, and at Edgewood Arsenal and Fort Detrick bearing upon warfare defoliants and exposure of humans to these agents. Other Published Searches in this series on chemical warfare cover detection and warning, protection, general studies, and biological studies, including chemistry and toxicology. (This updated bibliography contains 262 citations, 10 of which are new entries to the previous edition.)

54 ENVIRONMENTAL SCIENCES

5401 Environmental Sciences, Atmospheric

Refer also to citation(s) 32095, 32096, 32098, 32105, 32136, 32137, 32138, 32139, 32140, 32141, 32142, 32143, 32144, 32145, 32146, 32150, 32151, 32161, 32211, 32270, 32277, 32309, 32310, 32446, 32450, 32480, 32481, 32510, 32512, 32701, 32708, 32974, 33035, 33114, 33120, 33121, 33124, 33131, 33132, 33134, 33135, 33147, 33163, 33185, 33236, 33237, 33251

33046 (BMU–1990-241/1+2) **Wind tunnel tests on the evaluation of interferences due to buildings on the propagation of radioactive materials after release from nuclear facilities. Report and annex.** Schriftenreihe Reaktorsicherheit und Strahlenschutz. Ergebnisberichte, Untersuchungen, Studien, Gutachten. Schuler, A.K.; Guglhoer, P. Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.); Technischer Ueberwachungs-Verein Bayern e.V., Muenchen (Germany, F.R.). 1990. 525p. (In German). Contract BMU St.Sch. 996. Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.).

Published in 2 separate volumes.

As references the simulated boundary layer in a wind tunnel and the diffusion parameters of the Gaussian plume model for undisturbed releases are described. The effects of the source-location is shown for a cubic structure. The effects of the building's width, length and height are shown. The effects of the distance between two buildings with the same geometric characteristics are shown. For the chosen boundary conditions results about the maxima of concentrations and the plume trajectories are worked out. For some selected cases Gaussian diffusion parameters are determined to describe the influence of the buildings on the dispersion by using the Gaussian plume model. (orig.).

33047 (BNL–44496) **Urban modeling of organic aerosol source emissions.** Hildemann, L.M. (Stanford Univ., Palo Alto, CA (USA)); Cass, G.R.; Mazurek, M.A. Argonne National Lab., IL (USA). Apr 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900794–1: ASCE conference on environmental engineering, Washington, DC (USA), 9-11 Jul 1990). Order Number DE90010651. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A mathematical model was used to predict the characteristics of fine organic aerosol that would be present in the Los Angeles atmosphere if direct organic aerosol source emissions were transported without chemical reaction. The model was successful at tracking both the seasonal variations observed in ambient samples of organic aerosol, and the distribution of the urban organic material present as a function of gas chromatographic elution time. Using the model, the major sources of urban organic aerosol were

identified for this urban area. Differences between ambient measurements and model predictions were used to assess the degree of secondary organic aerosol formation. 5 refs., 1 tab.

33048 (CONF-900676–6) **Emissions involved in acidic deposition processes: Methodology and results.** Placet, M. Argonne National Lab., Washington, DC (USA). [1990]. 17p. Sponsored by U.S. DOE Office of Policy, Planning and Analysis. DOE Contract W-31109-ENG-38. From 83. annual meeting and exhibition of the Air and Waste Management Association; Pittsburgh, PA (USA); 24-29 Jun 1990. Order Number DE90011152. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Data on the emissions involved in atmospheric acid-base chemistry are crucial to the assessment of acidic deposition and its effects. Sulfur dioxide (SO_2), nitrogen oxides (NO_x), and volatile organic compounds (VOCs) are the primary chemical compounds involved in acidic deposition processes. In addition, other emission species – e.g., ammonia, alkaline dust particles, hydrogen chloride, and hydrogen fluoride – are involved in atmospheric acid-base chemistry, either by contributing acidic constituents or by neutralizing acidic species. Several emissions data bases have been developed under the auspices of the National Acid Precipitation Program (NAPAP). In addition to those developed by NAPAP, emissions data bases and emissions trends estimates also have been developed by organizations such as the Electric Power Research Institute (EPRI) and the U.S. Environmental Protection Agency (EPA). This paper briefly describes and compares the methods used in developing these emissions data bases and presents an overview of their emissions estimates. A more detailed discussion of these topics can be found in the State-of-Science Report on emissions recently released by NAPAP and in the references cited in that report. 14 refs., 4 figs., 1 tab.

33049 (CONF-900724–2) **Summertime elevation of radon in southern Appalachian homes.** Gammage, R.B.; Wilson, D.L. Oak Ridge National Lab., TN (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 5. international conference on indoor air quality and climate; Toronto (Canada); 29 Jul - 3 aug 1990. Order Number DE90009237. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

For houses in particular countries of the southern Appalachians, the atypical situation arises of higher indoor levels of radon during summertime rather than wintertime. Where such conditions prevail, it is recommended that houses be screened for elevated radon during warmer rather than colder seasons of the year. This paper discusses the materials and methods used for the screening, the results and conclusions, and presents some recommendations. 7 refs., 1 fig., 1 tab.

33050 (CONF-900724–6) **Determination of airborne organics by direct sampling mass spectrometry.** Wise, M.B.; Buchanan, M.V.; Guerin, M.R. Oak Ridge National Lab., TN (USA). [1990]. 7p. Sponsored by U.S. Department of Defense; U.S. Department of Health and Human Services. DOE Contract AC05-84OR21400. From 5. international conference on indoor air quality and climate; Toronto (Canada); 29 Jul - 3 aug 1990. Order Number DE90009422. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Two new state-of-the-art mass spectrometer systems are currently being evaluated for the determination of part-per-billion levels of organics in ambient air. These instruments include an ion trap mass spectrometer (ITMS) and a glow discharge quadrupole mass spectrometer (GDMS). Both of these instruments can be configured for direct air sampling or may be operated in conjunction with thermal desorbers for the analysis of samples preconcentrated on resin traps. Glow discharge ionization is particularly amenable to direct air monitoring; however, the use of a single quadrupole mass analyzer limits the ultimate specificity of this particular system. Important features of the ITMS include the ability to perform selective chemical ionization as well as collision induced dissociation (CID) tandem mass spectrometry (MS/MS) for compound identification. Applications of this technology have included the determination of ambient nicotine in environmental tobacco smoke (ETS), the determination of trace levels of organo-phosphonates in air, and the detection of target volatile organics in indoor atmospheres. 2 refs., 5 figs.

33051 (CONF-900775–1) **Potential responses of landscape boundaries to global environmental change.** Turner, M.G.; Gardner, R.H.; O'Neill, R.V. Oak Ridge National Lab., TN (USA). [1990]. 35p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Annual conference of Ecological Society of America; Snowbird, UT (USA); 29 Jul - 2 aug 1990. Order Number DE90008568. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Global change is likely to affect the location, size, shape, or composition of landscape boundaries. Neutral models were used to study two general mechanisms by which landscape boundaries may respond to global change: (1) disturbance regimes may change in response to climate, leading to rapid alterations in landscape structure, and (2) in the absence of disturbance, suitable habitat for different species may move gradually and directionally. The spread of disturbance was simulated as a function of the proportion of the landscape occupied by a disturbance-prone habitat and the frequency and intensity of a habitat-specific disturbance. The effects of changing disturbance regimes on landscape boundaries were different in connected and fragmented landscapes. In connected landscapes, an increase in disturbance intensity caused landscape boundaries to decrease. In landscapes that were fragmented, an increase in disturbance frequency resulted in a decrease in landscape boundaries. Habitat displacement and species migration were simulated as a function of the proportion of half of a landscape occupied by a community, migration, extinction, and the rate at which potential habitat is displaced. 39 refs., 8 figs., 2 tabs.

33052 (CONF-8306308–) **The earth's electrical environment: Studies in geophysics.** National Research Council, Washington, DC (USA). Geophysics Study Committee. 1986. 263p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; National Academy of Sciences/National Academy of Engineering/Institute of Medicine; National Aeronautics and Space Administration; National Science Foundation; U.S. Geological Survey. DOE Contract FG01-82ER12018. From American Geophysical Union symposium: the earth's electrical environment; Baltimore, MD (USA); Jun 1983. Order Number DE90010444. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

This study is part of a series of Studies in Geophysics that have been undertaken for the Geophysics Research Forum by the Geophysics Study Committee. One purpose of each study is to provide assessments from the scientific community to aid policymakers in decisions on societal problems that involve geophysics. An important part of such assessments is an evaluation of the adequacy of current geophysical knowledge and the appropriateness of current research programs as a source of information required for those decisions. It is clear that modern technological advances can be seriously affected by various atmospheric electrical processes and that man is also beginning to affect the electrical environment in which he resides. The study reviews the recent advances that have been made in independent research areas, examines the interrelations between them, and projects how new knowledge could be applied for benefits to mankind. The study also indicates needs for new research and for the types of coordinated efforts that will provide significant new advances in basic understanding and in applications over the next few decades. It emphasizes a need to consider the interactions between various atmospheric, ionospheric, and telluric current systems that will be necessary to achieve an overall understanding of global electrical phenomena. This volume contains 16 papers. Individual papers are indexed separately on the energy database.

33053 (CONF-9005171–1) **International decision making and global climate change: Lessons of prior resource management efforts for consensus building.** Feldman, D.L. Oak Ridge National Lab., TN (USA). [1990]. 56p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 3. symposium on social science in resource management; College Station, TX (USA); 16-19 May 1990. Order Number DE90010714. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

International cooperation aimed at furthering awareness of anthropogenic climate change has been relatively rapid, but developing strategies for prevention or mitigation has taken more time.

This is because anthropogenic climate change poses several particularly difficult obstacles to an integrated global strategy. These include conceiving of the atmosphere as a shared, sustainable resource, agreeing upon the causes, rates, and responsibilities of induced change among national actors, minimizing collateral effects of economic development while optimizing growth, particularly in LDCs, and encompassing the complexity of the problem's various ramifications in a multilateral policy. This paper addresses the availability of an incremental and iterative learning process for enhancing international cooperation in the management of global climate change. Through an examination of three case studies: regional seas, ozone, and nuclear materials regulation, models for global cooperation are identified which effectively encompass concerns over the size and distribution of correction costs among countries, the uncertainties involved in identifying cause-effect relationships, the vulnerability of shared resources, and the divergent needs of developed and developing countries. 132 refs., 3 tabs.

33054 (DOE/ER/60372–5) **Multi-dimensional aspects of recent climate change in North America: Progress report, August 15, 1989–April 1, 1990.** Kukla, G.J. (Columbia Univ., Palisades, NY (USA). Lamont-Doherty Geological Observatory); Gavin, J.E.; Karl, T.R. Columbia Univ., Palisades, NY (USA). Lamont-Doherty Geological Observatory. Apr 1990. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-85ER60372. Order Number DE90010958. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Work on the project began in August 1989. Our objectives are: to identify and analyze time related changes in the properties and frequency of individual air masses over North America, and to determine the degree to which the observed changes agree with the predictions of climate models testing the CO_2 impact. Climate models predict a substantial warming of the surface air temperature due to increased levels of atmospheric CO_2 and other trace gases. These greenhouse gases are expected to affect various air masses differently. Changes in the properties of individual air masses and their frequency will be used to assess climate change. Particular attention will be given to moisture dependent variables which can mask the CO_2 signal. 10 refs.

33055 (EGG–10617-1031) **An aerial radiological survey of the Evans Area, US Army Communications-Electronics Command, Fort Monmouth, New Jersey: Date of survey, November 1988.** Maurer, R.J. EG and G Energy Measurements, Inc., Las Vegas, NV (USA). Remote Sensing Lab. Dec 1989. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-88NV10617. Order Number DE90011190. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An aerial radiological survey was conducted over the Evans Area, US Army Communications-Electronics Command, Fort Monmouth, New Jersey, during the period November 14–18, 1988. The purposes of the survey were to document the terrestrial gamma environment of the Evans site and surrounding area and to determine if there had been any radiological impact on the area due to past laboratory operations. The results of the aerial survey are reported as inferred radiation exposure rates at 1 meter above ground level in the form of a contour map. The aerial data were compared to ground-based "benchmark" exposure rate measurements and radionuclide assay of soil samples obtained at sites outside the survey perimeter. Similar ground-based measurements were also made at several locations on the Evans site and at the bank of the Shark River bordering the Evans Area. No evidence for contamination was identified by either radionuclide assay of soil samples or the aerial survey. 6 refs., 5 figs., 2 tabs.

33056 (EGG–10617-1040) **Effectiveness of water spray mitigation systems for accidental releases of hydrogen fluoride: Volume 6, Appendix H, Selected still photographs.** Schatz, K.W.; Koopman, R.P. Industry Cooperative Hydrogen Fluoride Mitigation/Assessment Program (USA). Water Spray Subcommittee. Jun 1989. 114p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-88NV10617. Order Number DE90007134. Available from NTIS, PC A06/MF A01 - OSTI.

This report is one of several work products generated by the Industry Cooperative HF Mitigation/Assessment Program. This ad hoc industry program began in late 1987 to study and test techniques for mitigating accidental releases of hydrogen fluoride (HF) and alkylation unit acid (AUA) and to better estimate ambient impacts from such releases. The hazards of HF have long been recognized. Standard operating practices focused on minimizing the possibility of a release and mitigating the effects if a release should occur. These practices are continually monitored and improved to maximize safety protection based on the available technical data. This recent program targeted further improvements based on new technical data. This document, Volume 6, provides selected still photographs of tests and test facilities as Appendix H of the report. 107 figs., 1 tab.

33057 (EGG–10617-1044) **An aerial radiological survey of the United States Department of Energy's Rocky Flats Plant, Golden, Colorado: Date of survey, July 1989.** Boyns, P.K. EG and G Energy Measurements, Inc., Las Vegas, NV (USA). Remote Sensing Lab. May 1990. 36p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-88NV10617. Order Number DE90011191. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The aerial radiological survey of the Rocky Flats Plant and surrounding area was conducted during July 1989 by EG&G/EM for the DOE. The survey consisted of airborne, in situ, and soil sample measurements of the natural and man-made gamma radiation sources in around the plant site. The survey was conducted at the request of DOE Headquarters in support of the Tiger Team investigation to determine if changes had occurred in the radiation profile of the Rocky Flats area as a result of plant operations since a prior survey in 1981. Germanium detector measurements were made at 1.0 m above ground level (AGL) to verify the aerial data. Since the germanium has a lower minimum detectability for Am-241, it was used to refine the deposition isopleths both spatially and quantitatively. Soil samples were collected at each measurement location. 7 refs., 28 figs., 12 tabs.

33058 (GAO/RCED–90-15) **Air pollution: National air monitoring network is inadequate.** General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div. Dec 1989. 50p. Available from US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877 (USA).

This paper presents a GAO report. The Environmental Protection Agency reports that over 100 million people live in areas where air pollution exceeds national air quality standards. This conclusion was reached primarily on the basis of the results of a nationwide network of air monitors that measure compliance with the standards. Although EPA regulations required the agency to have a national air monitoring network in place by July 1982, GAO found that the network is still incomplete. EPA has cited insufficient funds at the federal, state, and local levels as a major barrier to completion of the network. More funds will be needed to complete the monitoring network and will continue to be needed to by additional monitors and replace aging equipment. GAO also found that EPA quality control measures, such as bi-annual reviews of state and local monitoring programs, have not ensured the accuracy and reliability of data provided by national, state, and local monitoring networks. In some cases, quality controls do not meet EPA criteria for thoroughness or effectiveness. Further, EPA's accuracy testing of state and local air monitors in questionable since the agencies are allowed to choose which monitors are to be tested.

33059 (IC–89/244) **On the dynamics of severe thunderstorms.** Abdel Wahab, M. International Centre for Theoretical Physics, Trieste (Italy). Sep 1989. 11p. Order Number DE90627922. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A detailed study of widespread thunderstorm activity occurring in winter over the central and coastal parts of Egypt (Cairo 30 deg. N, Marsa Matruh 31 deg. N) is presented. The storm activity is associated with strong positive vorticity in the 300/200 mb layer. The maximum kinetic energy was located at the storm centre. The divergent wind component was found to be very important in energy transformation and it is a major cause for energy generation by cross contour flow. (author). 10 refs, 7 tabs.

33060 (K/QT–222) **Demonstration of noble gas collection using the cryogenic technique.** Moser, L.V.; Delzer, D.B. Oak Ridge Gaseous Diffusion Plant, TN (USA). Sep 1988. 18p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OT21400. Order Number DE90010895. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Monitoring devices used for detecting and measuring airborne radioactive noble gases in stack emissions have been limited in their precision and detection capability. Cryogenic sampling is one method used for sampling gamma emitting radioactive gases in stack emissions. A cryogenic air sampler, originally developed at the Oak Ridge National Laboratory (ORNL) and further developed by the Systems Demonstration and Environmental Air Sampling Group (SDEASG) at the Oak Ridge Gaseous Diffusion Plant (ORGDP) is being tested. The cryogenic sampler will be used to study the off-gas from various emission points at ORNL after completion of the preliminary study by SDEASG. Work is currently under way to demonstrate the effectiveness of the sampler and the efficiency of the sampling method. Various tests have been and are being conducted to determine the sample collection techniques which will result in the greatest sample transfer efficiency, sampling precision, and gamma emission counting efficiencies. 4 figs., 2 tabs.

33061 (LA-UR–90-1332) **Numerical simulations of the mountain iron tracer data.** Yamada, T.; Bunker, S. Los Alamos National Lab., NM (USA). [1990]. 7p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-900435–1: International symposium on measurement of toxic and related air pollutants, Raleigh, NC (USA), 30 Apr - 3 may 1990). Order Number DE90009749. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Extensive field experiments were conducted during 1965 and 1966 near Vandenberg Air Force Base. The experiments included wind speed and wind direction measurements at several towers, upper air soundings by radiosondes, and fluorescent particle releases to characterize the diffusion processes. The data provide a unique opportunity to test numerical models under realistic boundary conditions: land-sea contrast and complex topography. We used HOTMAC (High Order Turbulence Model for Air Circulations), a three-dimensional mesoscale model based on simplified turbulence-closure equations to simulate temporal and spatial variations of wind, temperature, mixing ratio of water vapor, and turbulence distributions. Surface concentrations were computed by using a three-dimensional transport and diffusion model RAPTAD (Random Puff Transport and Diffusion). RAPTAD is a Lagrangian puff code based on the Monte Carlo statistical diffusion process. The center location and standard deviation of concentration distribution for each puff are computed by using wind and turbulence modeled by HOTMAC. Then, the concentration at any location is computed by summing concentrations contributed by all the puffs. The purpose of this study is to simulate the transport and dispersion of atmospheric pollutants in the complex terrain surroundings at Vandenberg Air Force Base by using the Los Alamos national Laboratory (LANL) atmospheric models HOTMAC and RAPTAD.

33062 (MHSMP–89-27) **Pantex Plant site environmental report for calendar year 1988.** Laseter, W.A.; Langston, D.C. Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA). May 1989. 111p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00487. Order Number DE90010342. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This report summarizes the environmental monitoring program at Pantex plant for 1988. This report presents monitoring data for both radioactive and non-radioactive species in the local environment. Plant activities involve the handling of significant quantities of uranium, plutonium and tritium in the form of completed parts received from other DOE (Department of Energy) facilities, resulting in a very low potential for release of these radionuclides to the atmosphere. Monitoring data indicate that concentrations of this nuclide in the environment are below established criteria for air and water and therefore should not present a health hazard either to employees or to the public. 23 refs., 12 figs., 34 tabs.

33063 (NIRS-M–73, pp. 63-78) **Radon and its progeny at the elevated areas in Japan.** Amano, Hikaru (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Yanase, Nobuyuki; Matsunaga, Takeshi; Kasai, Atsushi. National Inst. of Radiological Sciences, Chiba (Japan). Mar 1989. (In Japanese). (CONF-8712153–: 15. NIRS seminar on environmental research, Chiba (Japan), 3-4 Dec 1987). In *Radon in the living environment: Levels and risks.* Order Number DE90705994. Available from NTIS (US Sales Only), PC A15/MF A01.

Inhalation of radon and its progeny has recently been a major concern for the public in Japan in terms of their effects on internal radiation dose. Higher levels of radon and its progeny are observed within the selected zones where humans are living, as well as houses. This report presents analysis for the measurement of radon and its progeny in some areas with higher levels, and evaluation for the internal radiation dose. Radon and its progeny in the enclosed cave have been measured simultaneously by using liquid scintillation method and alpha-ray spectrometry, respectively. Emanation factor from rock in the cave was estimated. A negative correlation was observed betweent the radon concentration in cave air and the barometric pressure. Size distributions of Pb-214 and Bi-214 were determined by using an Andersen cascade impactor sampler. Activity median aerodynamic diameters of both nuclides were found to be 0.5 μm. For persons working in such a cave, the exposure dose was estimated to be 1.4-14 mSv. Radon and its progeny have also been measured in a spa area, which is characterized by having a higher level of radon, as well as in the air. The ratio of the radon/its progeny level was found to be small in the air. This implies that exposure doses may be low in taking spa bath where the radon level is high. In an experimentally prepared basement in the house, air exchange rate and wind velocity was measured. There was a negative correlation between radon and its progeny levels in the first floor and wind velocity. The ratio of the radon/its progeny level was found to be larger in the first floor than the basement, suggesting that exposure doses in the basement and the first floor are the same, even when the levels are higher in the basement. (N.K.).

33064 (NIRS-M–73, pp. 79-88) **A nation-wide survey of radon indoors and outdoors in Japan.** Abe, Michiko (National Inst. of Radiological Sciences, Chiba (Japan)); Abe, Siro. National Inst. of Radiological Sciences, Chiba (Japan). Mar 1989. (In Japanese). (CONF-8712153–: 15. NIRS seminar on environmental research, Chiba (Japan), 3-4 Dec 1987). In *Radon in the living environment: Levels and risks.* Order Number DE90705994. Available from NTIS (US Sales Only), PC A15/MF A01.

A nation-wide survey of radon concentration was conducted to estimate contributions of radon and its daughters to the population dose in Japan. A total of 500 monitoring apparatuses were distributed in 13 carefully selected prefectures, taking into account geographical configurations to Pacific Ocean and Asian Continent that would be a significant source of radon, as well as areas of heavy snowfall, basin, and seagirt sites. Two hunderd and fifty houses, made of wood or concrete, were measured indoors and outdoors. The monitoring apparatuses were settled mainly in bed rooms and living rooms where inhabitants would stay for a long time. Cellulose nitrate (CN) films along with drying agent (P_2O_5) were exchanged every two months. The etch tracks on the films represented the integrated radon concentration over two months. Such a procedure was repeated for more than 1.5 years, and a total of 5,000 films or more were finally obtained. Analyses of the CN films revealed: (1) radon concentration was generally high between fall and spring, and low in summer; (2) it tended to be higher in northern than southern areas; (3) the indoor concentration of radon was generally double that the outdoor concentration (10 Bq/m^3 vs 5 Bq/m^3); (4) both indoor and outdoor radon concentrations did not differ largely from those obtained in the United Kingdom. (N.K.).

33065 (NIRS-M–73, pp. 105-113) **Meteorological factors influencing on the radon concentrations in indoor and outdoor airs.** Kojima, Hiroshi (Science Univ. of Tokyo, Noda, Chiba (Japan). Faculty of Science and Technology). National Inst. of Radiological Sciences, Chiba (Japan). Mar 1989. (In Japanese). (CONF-8712153–: 15. NIRS seminar on environmental research, Chiba (Japan), 3-4 Dec 1987). In *Radon in the living environment:*

Levels and risks. Order Number DE90705994. Available from NTIS (US Sales Only), PC A15/MF A01.

Factors influencing radon concentrations in indoor and outdoor airs are discussed. A balance between source and loss is required in determining the radon concentration. Source refers to as the outdoor and indoor exhalation rate from the ground and the building materials. Loss is caused by turbulent diffusion outdoors and ventilation indoors. A significant factor influencing the exhalation rate of indoor and outdoor radon may be the change in atmospheric pressure. A drop of pressure feeds the high concentration air under the ground or building materials into the open air, and contributes to the increased exhalation rate. The exhalation rate of radon closely depends on the moisture content of the ground or building materials. Up to a certain level of moisture, the radon exhalation increases with increasing moisture content because the emanation power increases by a recoil effect of a fluid present in the internal pores of the materials. Beyond a certain level of moisture, the exhalation decreases rapidly because the pores are filled with water. Radon exhalated from the ground is spread out by turbulent diffusion. There is a remakable difference between indoor and outdoor radon concentrations. The ventilation rate of the house exerted a great effect upon the indoor radon concentration. The ventilation rate is influenced by meteorological factors together with human activities. Of such factors, wind velocity and temperature gradient between indoor and outdoor airs may be the most significant. The correlation coefficients between RaA or radon and some meteorological factors were calculated on the data from the long term measurements on radon and its decay products in and out of a house under normal living conditions. The changes in atmospheric pressure and wind velocity are found to be a significant factor in the variation of concentration of these nuclides. (N.K.).

33066 (OME/WRBD–90-02029) **Report on the 1988 industrial direct discharges in Ontario.** Ontario Ministry of the Environment, Dorset, ON (Canada). Water Resources Branch. Dec 1989. vp. (MICROLOG–90-02029). Available from PC Ontario Ministry of the Environment, Public Information Office, 135 St. Clair Ave. West, Toronto, ON, CAN M4V 1P5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This annual update of the status of all industrial direct dischargers in Ontario includes monthly and yearly average loadings and effluent limits; actual monthly and yearly loadings vs. limits; fish toxicity test results where available; and trend analysis for petroleum refining, pulp and paper mills, and primary steel producers. Descriptions of the various effluents limits as requirements (by a legal document) or guidelines (a desirable objective), the company self-monitoring and the Ministry audit program, and the various sources and their effluent loadings are given. The report also includes a discussion on compliance, a table of new Ministry enforcement actions, tables of remedial actions for sources not meeting limits criteria, and a progress report on the Municipal Industrial Strategy for Abatement - MISA Program. Seventeen new sources were included and 6 sources were dropped. The number of companies meeting guidelines and requirements on a yearly basis was 122 or 72.6%, out of 168 sources reporting. On a monthly basis, 77 or 45.8% of companies met all limits. 3 figs., 8 tabs.

33067 (ORNL/FTR–3603) **[Finalization of the International Biospheric Model Validation Study]: Foreign trip report, April 22, 1990–April 28, 1990.** Hoffman, F.O. Oak Ridge National Lab., TN (USA). 9 May 1990. 30p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90011087. Available from NTIS, PC A03/MF A01 - OSTI.

The primary objectives of this meeting were to finalize the drafting of the International Biospheric Model Validation Study (BIOMOVS) final report and to discuss a draft proposal announcing continuation of BIOMOVS into Phase 2. The meeting was held in Paris, France, from April 23 through April 28, 1990, at the offices of INTAKTA, a French subsidiary of the Swedish firm KEMAKTA. The Swedish firm functions as the present secretariat for BIOMOVS. BIOMOVS has provided an international forum for testing and critically evaluating models commonly used to predict the transfer of radionuclides through the biosphere. Although other international efforts have addressed the evaluation and testing of radionuclides and other pollutants in primary environmental media such as the atmosphere and the oceans, BIOMOVS has been the first organization devoted to model testing in the field of radioecology. The task undertaken by BIOMOVS has been especially important because model testing and evaluation involve the transboundary transport between the primary environmental media and the biological elements within these media.

33068 (PB–90-169970/XAB) **Ambient concentrations of PCDDs/PCDFs (polychlorinated dibenzodioxins/dibenzofurans) in the South Coast Air Basin. Final report, 1987-1990.** Hunt, G.; Maisel, B.; Hoyt, M. ENSR, Acton, MA (USA). Jan 1990. 257p. Available from NTIS, PC A12/MF A02.

The study characterized ambient concentrations of polychlorinated dibenzodioxins and dibenzofurans (PCDDs and PCDFs, or dioxins) at several sites in the South Coast Air Basin. The sites represented industrial, commercial, residential, and background locations, some near known emission sources. Ambient monitoring results are presented as congener distributions at the various sampling sites, along with data on air mass flows. Ambient air was sampled with high-volume samplers which employed both a glass fiber filter to collect particulate matter, and a polyurethane foam trap to collect semivolatile organic compounds. Four seasonal sampling sessions were conducted in an attempt to approximate annual averages at each site. High resolution mass spectrometry was used to analyze the samples for the fifteen dioxin and furan congeners chlorinated in the 2, 3, 7, and 8 positions. Overall dioxin levels are reported as detected toxic equivalents, based upon a determination by the State Department of Health Services.

33069 (PB–90-172313/XAB) **Potential Effects of Global Climate Change on the United States. Appendix H. Infrastructure. Report to the Congress.** Smith, J.B.; Tirpak, D.A. Environmental Protection Agency, Washington, DC (USA). Office of Policy, Planning and Evaluation. May 1989. 179p. (EPA–230/05-89/058). Available from NTIS, PC A09/MF A01.

See also PB–89-161046, PB–89-161053, and PB–89-161061<510>N -00.

This appendix contains back-up research studies for The Potential Effects of Global Climate Change on the United States report for Congress (1989).

33070 (PB–90-172628/XAB) **Potential Effects of Global Climate Change on the United States. Appendix B. Sea-level rise. Report to the Congress.** Smith, J.B.; Tirpak, D.A. Environmental Protection Agency, Washington, DC (USA). Office of Policy, Planning and Evaluation. May 1989. 274p. (EPA–230/05-89/052). Available from NTIS, PC A12/MF A02.

See also PB–89-161046, PB–89-161053, and PB–89-161061.

The appendix contains back-up research studies for The Potential Effects of Global Climate Change on the United States report for Congress (1989).

33071 (PB–90-173881/XAB) **Potential Effects of Global Climate Change on the United States. Appendix G. Health. Report to the Congress.** Smith, J.B.; Tirpak, D.A. Environmental Protection Agency, Washington, DC (USA). Office of Policy, Planning and Evaluation. Jun 1989. 109p. (EPA–230/05-89/057). Available from NTIS, PC A06/MF A01.

See also PB–89-161046, PB–89-161053, and PB–89-161061.

The appendix contains health research studies for The Potential Effects of Global Climate Change on the United States report for Congress (1989).

33072 (PB–90-173899/XAB) **Potential Effects of Global Climate Change on the United States. Appendix L. Variability. Report to the Congress.** Smith, J.B.; Tirpak, D.A. Environmental Protection Agency, Washington, DC (USA). Office of Policy, Planning and Evaluation. Jun 1989. 110p. (EPA–230/05-89/059). Available from NTIS, PC A06/MF A01.

See also PB–89-161046, PB–89-161053 and PB–89-161061.

The appendix contains weather variability research studies for The Potential Effects of Global Climate Change on the United States report for Congress (1989).

33073 (PB–90-179136/XAB) **Diesels in the occupational environment: An environmental perspective.** Piacitelli, G.M.; Jones, W.G.; Gamble, J.F.; Timko, R.J. National Inst. for Occupational Safety and Health, Morgantown, WV (USA). Div. of Respiratory Disease Studies. 21 May 1985. 21p. Available from NTIS, PC A03/MF A01.

Following a brief review of the history and applications of diesel power, some aspects of diesel power in the workplace were investigated. The diesel engine has become a highly developed, heavy-duty power unit which is a predominant source of industrial power throughout the world, primarily since it can burn a low-grade fuel more efficiently and therefore cheaper than other internal-combustion or steam-power engines. Levels of carbon dioxide, carbon monoxide, and nitrogen dioxide (NO_2) in environments using diesel engines were compared. Studies of the operation of such equipment had been conducted in underground coal mines, metal and mineral ore mines, heavy equipment operations, engine repair shops for both transit buses and for railroad locomotives, ammunition warehouses using diesel forklifts, and submarines using auxiliary diesel engines. Results of an analysis of these studies indicated that the impact of diesel exhaust on air quality depends on the operations being performed, the emission controls applied and the amount of dilution provided by ventilation. NO_2 and diesel particulates were considered to be the critical pollutants. Various methods of reducing the emission levels were discussed.

33074 (PB–90-179268/XAB) **Health-hazard evaluation report HETA 87-075-1988, American Cyanamid, Wallingford, Connecticut.** Bicknell, R.; McManus, K.P.; Kaiser, E.A.; Koenig, J.; Fidler, A.T. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Sep 1989. 38p. (HETA–87-075-1988). Available from NTIS, PC A03/MF A01.

An evaluation was made of possible hazardous exposures to workers in the Metal Coated Fibers (MCF) department of American Cyanamid, Wallingford, Connecticut. A walk-through evaluation was made of the MCF where 24 employees worked to unwind graphite fibers as a continuous strand through plating tanks, plate nickel onto the fiber, dry it and rewind it. A second operation involved the use of epoxy resins on the nickel-coated fiber and then cutting the fiber into various sizes. Air-quality monitoring revealed the following concentrations: methyl chloroform, 7.7 to 48.15 mg/cu m; methylene chloride, 13.9 to 74.7 mg/cu m; nickel, 7.3 to 51.2 micrograms/cu m; and synthetic graphite, 0.00003 to 0.23 mg/cu m. Respirators were used in portions of the operation so that these amounts do not necessarily reflect employee exposure levels. Medical examinations revealed seven of 56 workers had a work-related rash. Only two employees had a positive patch test to nickel. The report concludes that excessive exposure to nickel and potential exposure to methylene chloride existed in the MCF department. Irritant dermatitis was apparently associated with exposures on the sizing line. Measures to be taken to reduce exposures to nickel and other chemicals are recommended.

33075 (PB–90-179300/XAB) **Health-hazard evaluation report HETA 87-371-1989, technical assistance to the Jamaican Ministry of Health, Kingston, Jamaica.** Matte, T.D.; Burr, G.A. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Sep 1989. 32p. (HETA–87-371-1989). Available from NTIS, PC A03/MF A01.

An investigation was made of possible hazardous working conditions existing in numerous backyard battery repair shops (BBRS) located in Kingston. Nineteen of 22 children in Kingston hospitalized due to lead poisoning lived at or near a BBRS. The geometric mean of the air lead concentrations in the BBRSs sampled was 21 micrograms/cubic meter (microg/cu m). The highest workplace concentration was 66 microg/cu m which exceeded the OSHA permissible exposure limit of 50 microg/cu m. Soil lead levels were significantly higher at households located at BBRS premises, compared with comparison households. The geometric mean soil lead levels were very high, 58,884 parts per million, with a range of 16,000 to 400,000 ppm. Dust lead levels were higher at exposed households than at comparison households. In many cases the dust lead content was associated with the number of batteries repaired at the site. Blood lead levels were strongly associated with the soil and dust lead levels. The report concludes that BBRS create a high lead poisoning risk for workers and nearby residents. Specific measures for reducing lead exposures are provided.

33076 (PB–90-180761/XAB) **NIOSH (National Institute for Occupational Safety and Health) testimony on indoor air quality by J. D. Millar on May 26, 1989.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 26 May 1989. 25p. Available from NTIS, PC A03/MF A01.

The testimony considered the work conducted by the National Institute for Occupational Safety and Health (NIOSH) in the area of indoor air quality. The quality of indoor air often worsened soon after energy-conservation measures were enacted at many business places following the Arab oil embargo in the 1970s. Concurrently, new office technologies in some cases presented chemical and physical hazards to the office staff as well. Of the 1200 NIOSH Health Hazard Evaluations performed between 1971 and 1978, six were to study indoor air-quality problems, or 0.5% of the total number of studies. Between 1978 to 1980 this percentage increased dramatically to 7.4% of the total and, since 1980 indoor air-quality studies have accounted for 12% of the total Health-Hazard Evaluation studies. Such pollution arises from human metabolic activity, smoking, structural components of the building and contents, biological contamination, office and mechanical equipment, and outside air pollutants that enter the building. In more than half the investigations, lack of adequate ventilation was the cause of the complaints. In 20 to 25% of the cases, sources inside the building were identified as the major generators of indoor air contaminants. Some major examples of governmental and nongovernmental research along this same line of study were highlighted.

33077 (PB–90-180894/XAB) **NIOSH (National Institute for Occupational Safety and Health) testimony on indoor air quality by J. Melius on August 3, 1989.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 3 Aug 1989. 13p. Available from NTIS, PC A03/MF A01.

The testimony concerned the activities of the National Institute for Occupational Safety and Health (NIOSH) and the Center for Environmental Health (CEH) of the Centers for Disease Control concerning indoor air quality. Since 1971 NIOSH has conducted over 200 indoor-air-quality investigations. More than 90% of these were conducted in the last 5 years. Nearly all were conducted in response to worker symptoms or illnesses which were thought to be related to the building environment in which the people were working. Generally, the indoor air pollution evaluations conducted were categorized by the source of contamination in the environment, if identified, or otherwise by the type of symptoms or illnesses experienced by the workers. These categories of contamination include contamination from outside the building, from building materials, from copying machines, hypersensitivity pneumonitis, from chemicals used in building maintenance, and inadequate ventilation. While more serious illnesses occasionally have been attributed to working in these building environments, no clear evidence of health problems more serious than apparent allergic reactions in a few individuals to specific office contaminants has been found. The CEH conducted a survey of State health department programs for hazard evaluations of nonoccupational indoor air pollution.

33078 (PB–90-181504/XAB) **Atmospheric ozone 1985: Assessment of our understanding of the processes controlling its present distribution and change. Volume 3.** World Meteorological Organization, Geneva (Switzerland). 1990. 558p. (WMO–16). Available from NTIS, PC A24/MF A03.

Also available from Supt. of Docs. Color illustrations reproduced in black and white.

Contents include: Chapter 12–assessment models; Chapter 13–model predictions of ozone changes; Chapter 14–ozone and temperature trends; Chapter 15–trace gas effects on climate; Appendix A–kinetics and photochemical data base; Appendix B–spectroscopic database–infrared to microwave; appendix c–instrument intercomparisons and assessments; Appendix D–monthly mean distribution of ozone and temperature; Appendix E–list of contributors; Appendix F–list of figures; Appendix G–list of tables; Appendix H–major acronyms; Appendix I–chemical formulae and nomenclature; Appendix J–pressure-altitude conversion chart; references.

33079 (PB–90-182494/XAB) **Policy options for stabilizing global climate. Draft report to congress. Executive Summary. Draft report.** Lashof, D.A.; Tirpak, D.A. Environmental Protection Agency, Washington, DC (USA). Office of Policy, Planning and Evaluation. Feb 1989. 120p. Available from NTIS, PC A06/MF A01.

The Executive Summary describes the goals established by EPS for the study, considering previous work and the Congressional mandate. The analytical framework developed for the study is briefly described and its limitations are noted. Current understanding of the greenhouse gases and their impact on global climate is summarized. A description of the scenarios that were developed to explore the sensitivity of the climate system to policy choices is presented next. The results of this scenario analysis follows, emphasizing the relative impact of various options. The technological and policy strategies that appear most promising for reducing greenhouse gas emissions are then presented by major-activity category: energy production and use, other industrial activities, changes in land use, and agricultural practices. The policy options that are available for promoting these emission-reduction strategies are then reviewed, giving consideration to the timing of policy responses to the Greenhouse gas buildup. Finally, the major findings of the study are summarized.

33080 (PB–90-183401/XAB) **Precision and accuracy assessments for state and local air-monitoring networks, 1988.** Smith, L.; Wu, J. Northrop Services, Inc., Research Triangle Park, NC (USA). Feb 1990. 195p. Available from NTIS, PC A09/MF A02.

See also report for 1988, PB–89-155246.

Precision and accuracy data obtained from state and local agencies (SLAMS) during 1988 are analyzed. Pooled site variances and average biases which are relevant quantities to both precision and accuracy determinations are statistically compared within and between states to assess the overall effectiveness and consistency in the application of various quality-assurance programs. Individual site results are evaluated for consistent performance throughout the year. Reporting organizations, states and regions which demonstrate consistent precision and accuracy data as the result of effectively administered quality-assurance programs are identified. The information is intended as a guide for identifying problem areas, for taking corrective action from the standpoint of improving the effectiveness of quality-assurance programs, and for providing more-knowledgeable decisions concerning attainment status with regards to ambient air-quality standards. An approach to deal with accuracy data for individual sites is presented, and an alternative sampling design for generating precision and accuracy data is discussed. A comparison of the SLAMS accuracy results with the corresponding results from the EPA national ambient-air audit program is also provided.

33081 (PB–90-183419/XAB) **Development and validation of a test method for formaldehyde emissions. Report for February 1987-April 1989.** Estes, E.D.; Gutknecht, W.F.; Hardison, D.L.; Howe, G.B.; Jayanty, R.K.M. Research Triangle Inst., Research Triangle Park, NC (USA). Feb 1990. 55p. Available from NTIS, PC A04/MF A01.

The document details the field validation of a test method for the sampling and analysis of formaldehyde emissions from stationary sources. Three potential source methods were evaluated. Field testing of the methods were conducted at two different sites. At a formaldehyde manufacturing plant, where formaldehyde levels were high (>100 mg/cu m), samples were collected using the basic peroxide impinger method and the DNPH impinger method. At a formaldehyde user facility, where formaldehyde levels were low, samples were collected using the DNPH-coated cartridge method and the DNPH impinger method. A statistical evaluation indicates that the DNPH impinger method is acceptable for determining both low and high concentrations of formaldehyde. Because of its range, this method is recommended as the reference method for determination of formaldehyde in source emissions.

33082 (PB–90-183427/XAB) **National Performance Audit Program: Acid rain audits, 1988.** Lampe, R.L.; Mitchell, W.J. NSI Technology Services Corp., Research Triangle Park, NC (USA). Feb 1990. 23p. Available from NTIS, PC A03/MF A01.

The report presents results of the Environmental Protection Agency's Semiannual U.S. Acid Rain Audit Program for 1988. When these audits, which are a part of the National Performance Audit Program (NPAP), were initiated in 1981, participation was limited to laboratories routinely analyzing acid rain samples. However, in 1988 invitations to participate were issued to all NPAP participants. As a result, only 52% of the results received for the 1988 audits came from laboratories that had been regular participants in the previous years' audits. Despite the many new participants, the percentage of participants who analyzed for a specific analyte was similar to that from previous audits. Also, as in previous audits, many participants had difficulty measuring accurately the concentration of the lowest cation and anion concentrations. Not unexpectedly, the percentage of the reported results identified as outliers was larger than in the 1985-1987 audits. The results for the heavy metals (Mn, Fe, Cd, Cu, Ni, Pb and Zn) were similar to earlier audits in that most of the participants reported an average result (for all seven metals) close to the expected value.

33083 (PB–90-184367/XAB) **Air Emissions Species Manual. Volume 2. Particulate-matter Species Profiles. Second edition. Final report, April 1988-October 1989.** Brooks, G.W.; Waddell, J.T.; Butler, W.A. Radian Corp., Research Triangle Park, NC (USA). Jan 1990. 784p. Available from NTIS, PC A99/MF E06.

See also PB–88-225800.

The U.S. Environmental Protection Agency (EPA) has several activities that require speciated particulate matter (PM) or volatile organic compound (VOC) profiles from several source categories. In an effort to update the available speciated PM profile data base, EPA initiated studies to update the Receptor Model Source Composition Library (EPA-450/4-85-002) and produce a revision entitled Air Emissions Species Manual - Volume II, Particulate Matter Species Profiles (EPA-450/2-88-003b). Similarly for VOC emissions, EPA performed studies to revise the Volatile Organic Compound Species Data Manual - Second Edition (EPA-450/4-80-015) and provide an updated version in the Air Emissions Species Manual - Volume I, Volatile Organic Compound Species Profiles (EPA-450/2-88-003a). The purpose of this document is to update the PM profiles in the Air Emissions Species Manual, Volume II, with new information obtained from contacts with principal researchers in the field of PM species profiles and source receptor modeling. The profiles are based on data voluntarily submitted by the researchers.

33084 (PB–90-184680/XAB) **Surface acoustic wave (SAW) gas microsensor for SO_2. Final report.** McAllister, D.J. BIODE, Inc., Cape Elizabeth, ME (USA). Oct 1987. 31p. Available from NTIS, PC A03/MF A01.

Researchers used sulfur dioxide as a model gas for testing the feasibility of developing a multicomponent sensor based on Surface Acoustic Wave (SAW) technology for the rapid identification and detection of ambient environmental gases in the sub-ppm to ppb range. Three different methods were examined in an attempt to impact SO2 specificity to several SAW devices: Chemical Bonded Adsorbents (CBA), Solvent Deposited Films, and Tungsten Trioxide (WO3). Results of the project are given. The major implication of the research will be the resulting merger of two existing technologies: metal oxide gas sensors (MEO) and surface acoustic wave devices (SAW).

33085 (PB–90-184896/XAB) **Evaluation of the role of ozone, acid deposition, and other airborne pollutants in the forests of eastern North America. Forest Service general technical report.** Garner, J.H.B.; Pagano, T.; Cowling, E.B. Forest Service, Asheville, NC (USA). Southeastern Forest Experiment Station. Dec 1989. 186p. (FSGTR-SE–59). Available from NTIS, PC A09/MF A01.

Also available from Supt. of Docs.

This document concentrates on the effects of airborne-pollutant chemicals on trees and in forest ecosystems of eastern North America by way of foliage-mediated response mechanisms. Many controlled-fumigation studies exposed seedlings in chambers to determine the exposure responses of a variety of trees to different pollutant chemicals. Though the document concentrates on the responses of trees to exposure to airborne chemical pollutants entering through the leaves, trees are also exposed through the soil and roots. Exposures to acid deposition and its sulfate and nitrate components via soil processes are discussed in the document only

briefly. Binkley and others (1989) have discussed in detail the impact of acid deposition on forest soils in the southeastern United States.

33086 (PB–90-185174/XAB) **Relationship between CO, POHC, and pic emissions from a simulated hazardous waste incinerator.** Staley, L.J.; Richards, M.K.; Huffman, G.L.; Olexsey, R.A.; Dellinger, B. Environmental Protection Agency, Cincinnati, OH (USA). Risk Reduction Engineering Lab. c 1989. 9p. (EPA–600/J-89/258). Available from NTIS, PC A02/MF A01.

Pub. in Jnl. of the Air Pollution Control Association, Vol. 39, No. 3, 321-327(Mar 1989).

Measurements conducted on full-scale hazardous waste incinerators have occasionally shown a relationship between carbon monoxide (CO) emissions and emissions of toxic organic compounds. In the study, four mixtures of chlorinated methane (C1) and ethane (C2) hydrocarbons were diluted in commercial-grade heptane and burned in a water-cooled Turbulent Flame Reactor under two different excess air levels. No correlation between CO and organic emissions could be discerned. Reasons for this lack of observable correlations are discussed in terms of combustion and chemical reaction kinetic theory.

33087 (PB–90-185844/XAB) **Air-Emissions-Species Manual. Volume 1. Volatile-organic-compound species profiles. Second edition. Final report, April 1988-October 1989.** Brooks, G.W.; Waddell, J.T.; Butler, W.A. Radian Corp., Research Triangle Park, NC (USA). Jan 1990. 640p. Available from NTIS, PC A99/MF A04.

See also PB–88-225792 and PB–90-146416.

The U.S. Environmental Protection Agency (EPA) has several activities that require speciated particulate matter (PM) or volatile organic compounds (VOC) profiles from several source categories. In an effort to update the available speciated PM-profile data base, EPA initiated studies to update the Receptor Model Source Composition Library and produce a revision entitled Air Emissions Species Manual - Volume II, Particulate Matter Species Profiles. Similarly for VOC emissions, EPA performed studies to revise the Volatile Organic Compound Species Data Manual - Second Edition and provide an updated version in the Air Emissions Species Manual - Volume I, Volatile Organic Compound Species Profiles. The purpose of the document is to update VOC profiles in the Air Emissions Species Manual, Volume I.

33088 (PB–90-186313/XAB) **Estimation of emissions from charcoal lighter fluid and review of alternatives. Final report.** Campbell, D.L.; Stockton, M.B. Radian Corp., Research Triangle Park, NC (USA). Progress Center. Jan 1990. 40p. (DCN–89-239-004-80-09). Available from NTIS, PC A03/MF A01.

The report gives results of an evaluation of emissions of volatile organic compounds (VOCs) from charcoal lighter fluid, a consumer product consisting entirely of volatile constituents. An estimated 46,250 tons (42,000 Mg) of charcoal lighter fluid is used in the U.S. each year. VOCs contribute to the formation of ozone; therefore, the ozone nonattainment issue has focused attention on VOCs emitted from many sources. VOCs are emitted when charcoal lighter fluid is used, but these emissions are difficult to quantify. Evaporative VOC losses occur from the lighter fluid prior to ignition, and combustion VOC losses occur from burning lighter-fluid-soaked charcoal briquettes. This study evaluates tests conducted to date on charcoal lighter fluid emissions. The information is most complete for evaporative VOC losses. The estimates vary greatly, however, based on the length of time between application of the lighter fluid and ignition. The limited tests conducted to date have not distinguished lighter fluid from charcoal-briquette combustion emissions.

33089 (PB–90-186339/XAB) **Operations and research at the US EPA Incineration Research Facility: Annual report for FY89.** Waterland, L.R. Acurex Corp., Jefferson, AR (USA). Mar 1990. 73p. Available from NTIS, PC A04/MF A01.

The Environmental Protection Agency's Incineration Research Facility in Jefferson, Arkansas, is an experimental facility which houses two pilot-scale incinerators and the associated waste-handling emission-control, process-control, and safety equipment, as well as onsite laboratory facilities. During Fiscal Year 1989, a major facility expansion and reconfiguration construction effort was completed. Upon completion of the construction, incineration testing at the Facility was resumed. Hazardous-waste-incinerator trace metal emission regulation development for the Office of Solid Waste and a Superfund site remediation treatability study for Region I and the Office of Emergency and Remedial Response were major program-support activities in Fiscal Year 1989.

33090 (PB–90-186354/XAB) **Evaluation of the wake effects on plume dispersion using video image analysis.** Rajala, S.A.; Trotter, D.S. North Carolina State Univ., Raleigh, NC (USA). Dept. of Electrical and Computer Engineering. Mar 1990. 303p. Available from NTIS, PC A14/MF A02.

Video images of smoke flow in the wake of a model building which were collected in previous wind-tunnel studies conducted by EPA at its Fluid Modeling Facility were further analyzed. Three distinct research projects were conducted. The first project evaluated existing image analysis/processing techniques to determine the contents of the data, develop a scheme for separating the smoke from the background, and ultimately determine the potential for analyzing the motion characteristics of the smoke flow. The second project used the theory of fractals to extract information from the smoke images. Results from these two projects identified a number of difficulties in trying to characterize smoke images. In the third project, a new technique for video imaging using laser sheet lighting was developed and tested. The resulting smoke images were observed to be more distinct and the noise levels were lower.

33091 (PB–90-187170/XAB) **Urban aerosol transformation and transport modeling. Report for October 1985-October 1988.** Seo, Y.; Brock, J.R. Texas Univ., Austin, TX (USA). Dept. of Chemical Engineering. Feb 1990. 51p. Available from NTIS, PC A04/MF A01.

Modules for secondary aerosol formation included in the urban-scale K-theory aerosol model, AROSOL are: An empirical first-order SO_2 conversion scheme, termed EMM; The lumped-parameter kinetic model termed the Carbon Bond Mechanism, in the version CBM-IV; The lumped-parameter kinetic model termed the Atkinson Lloyd Mechanism, in the 1985 ERT version; The equilibrium Model for an Aerosol Reacting System (MARS) for prediction of equilibrium partition of nitrates, sulfates, and ammonium between the gas and aerosol phases; The Binary Aerosol Dynamics Model for nucleation and growth of secondary aerosol. The modules for secondary-sulfate and -nitrate formation were demonstrated with data from the 1982 Philadelphia Aerosol Field Study. Both EMM and CBM give similar secondary-sulfate concentrations. EMM was found to give secondary sulfate concentrations around ten times those with CBM. MARS was used to demonstrate secondary-sulfate speciation from the conversions given by CBM. From the CBM calculations, nitrate speciation calculated by MARS was also obtained.

33092 (PB–90-187238/XAB) **National Dry Deposition Network: Second annual progress report (1988).** Edgerton, E.S.; Lavery, T.F.; Hodges, M.G.; Bowser, J.J. Hunter/ESE, Inc., Gainesville, FL (USA). Mar 1990. 101p. Available from NTIS, PC A06/MF A01.

Progress in the National Dry Deposition Network during calendar year 1988 is presented. The network configuration and operating procedures for the field, laboratory, and data management center are described, and data are summarized. Forty-three sites were operational at the close of 1988. Each site was equipped with sensors for measuring ozone and meteorological parameters required by inferential dry deposition algorithms. Weekly average day/night concentrations of sulfate, nitrate, sulfur dioxide, and nitric acid were measured using a three-stage filter pack. Sodium, potassium, calcium, magnesium, and ammonium were measured during half of the year. Ambient concentration data for 18 sites operational throughout the year showed species-dependent variability from site to site, season to season, and day to night.

33093 (PB–90-191990/XAB) **Southern California Air Quality Study (SCAQS) description of measurement activities. Final report.** Hering, S.V.; Blumenthal, D.L. Sonoma Technology, Inc., Santa Rosa, CA (USA). 18 Dec 1989. 140p. (STI–96030-810FR). Available from NTIS, PC A07/MF A01.

The goal of the Southern California Air Quality Study (SCAQS) was to develop a data base for the Los Angeles Basin that can be used to test, evaluate, and improve models for oxidants, PM10, fine particles, toxic air contaminants, and acidic species. In addition, SCAQS data will be used to address questions regarding the emission, transport, transformation, and deposition of pollutants. The report documents the SCAQS measurements which were conducted in the Los Angeles Basin over 13 weeks in the summer and fall of 1987. Routine air quality and meteorology measurements were made continuously throughout the study period. On 17 selected intensive study days, measurements were made at several locations throughout the Basin of: reactive and toxic gases (including PAN, H2O2, speciated hydrocarbons, and carbonyls), aerosol chemistry, aerosol size distribution, selected aerosol chemical species as a function of size, and light scattering and extinction. LIDAR backscatter and aerosol and reactive gas measurements were also made by aircraft.

33094 (PB–90-501412/XAB) **National Acid Precipitation Assessment Program (NAPAP) county-level alkaline emission estimates for unpaved roads. Dust Devils and wind erosion, 1985 (for microcomputers). Data file.** Masser, C.C.; Barnard, W.R. Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab. 1990. vp. Available from NTISCP D03.

See also PB–90-501008. The data file is contained on 5 1/4-inch diskettes, high density (1.2M), compatible with the IBM AT microcomputer. The diskettes are in the LOTUS 1-2-3 format. Price includes documentation, PB–90-172586.

The two floppy diskettes contain the data summary tables included in Appendices A, B, and C of the report Development of County-Level Wind Erosion and Unpaved Road Alkaline Emission Estimates for the 1985 NAPAP Emissions Inventory. The data tables are formatted in LOTUS 1-2-3 version 2.01 format (although they were written using Microsoft EXCEL Version 2.1). Each of the files represent one of the Appendices. It should be noted that in the report, only counties that had non-zero Dust Devil emissions were included in Appendix C. The corresponding file provides information for all counties in the continental U.S. even though most counties have Dust Devil emissions equal to zero.

33095 (PB–90-501487/XAB) **Roadmaps to sources of information on chemicals listed in the Emergency Planning Community and Community Right-To-Know Act also known as SARA (Superfund Amendments and Reauthorization Act) Title III, Section 313. Toxic Release Inventory (for microcomputers). Data file.** Leitzke, J.; Edelstein, M. Environmental Protection Agency, Washington, DC (USA). Office of Toxic Substances. 14 Jul 1989. vp. Available from NTISCP D04.

Supersedes PB–89-133631. See also PB–90-501479. The data file is contained on 5 1/4-inch diskettes, double density (360K), compatible with the IBM PC microcomputer. The diskettes are in the dBase III CLIPPER compiler format. Price includes documentation, PB–90-174855.

EPA has developed a database of sources of information on the chemicals listed in Section 313 of the Emergency Preparedness & Community Right-To-Know Act, Title III of the Superfund Amendments and Reauthorization Act. The database is intended to assist users of Section 313 Toxic Release Inventory data to perform exposure and risk assessments of these chemicals. The Roadmaps system displays and/or prints out information for the Section 313 chemicals on health and environmental effects, Federal Regulation, and state air and water regulations, monitoring data, and state contacts.

33096 (PB–90-501560/XAB) **Volatile organic compound and particulate-matter speciation data base (for microcomputers). Data file.** Kuykendal, W.B.; Patterson, G. Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards. Oct 1989. vp. Available from NTISCP D05.

See also PB–83-195511. The data file is contained on 5 1/4-inch diskettes, high density (1.2M), compatible with the IBM PC/AT microcomputer. The diskettes are in the ASCII format.

The data base contains speciation factors for both volatile organic compounds (VOC's) and particulate matter (PM) from a number of source categories. The speciation factors are the weight percent of the individual compounds or elements that make up either total VOC or total PM. By applying these speciation factors the user can estimate compound specific emissions when only total VOC or PM emissions are known. The VOC data base contains approximately 275 profiles from 28 source categories. The PM data base contains approximately 300 profiles from 20 source categories. Source categories are identified by Source Category Classification and compounds are identified by Chemical Abstracts Services number. The data bases have been published in the following two volume report. Air Emissions Species Manual Volume I Volatile Organic Compound Species Profiles, second edition, EPA-450/2-90-001a, January 1990 and Air Emission Species Manual Volume II Particulate Matter Species Profiles, second edition, EPA-450/2-90-001b, January 1990.

33097 (PB–90-863507/XAB) **Fluidized-bed combustion: Air pollution analyses. November 1970-March 1990 (A Bibliography from the NTIS data base). Report for November 1970-March 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 175p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning research of air-pollution conditions attributable to the operation of fluidized-bed combustion systems. Analyses and studies of combustion processes, emissions, environmental impact, and cost summaries are provided. Air-pollution-abatement and mechanical/chemical processes are described in separate bibliographies. (Contains 310 citations fully indexed and including a title list.)

33098 (PB–90-863515/XAB) **Fluidized-bed combustion: Air-pollution abatement. September 1972-March 1990 (A Bibliography from the NTIS data base). Report for September 1972-March 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 60p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the abatement of air-pollution environments attributable to the operation of fluidized-bed combustion systems. Analyses and studies of combustion processes, fuels, regulations, and control equipment are provided. Air-pollution control and mechanical/chemical processes are described in separate bibliographies. (Contains 87 citations fully indexed and including a title list.)

33099 (PB–90-863556/XAB) **Air pollution control using particle filtration. March 1982-March 1990 (A Bibliography from the NTIS data base). Report for March 1982-March 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 140p. Available from NTISPC N01/MF N01.

Supersedes PB–85-855625.

This bibliography contains citations concerning the use of particle filtration techniques and equipment in air pollution control operations. Fabric, membrane, and granular bed filters are among the devices considered. Equipment descriptions and performance evaluations of specific test installations, and filters used in samplers and monitors are discussed. Citations pertaining exclusively to electrostatic precipitators are excluded. (This updated bibliography contains 237 citations, 141 of which are new entries to the previous edition.)

33100 (PB–90-863606/XAB) **Volcanic eruptions: Atmospheric effects. May 1970-February 1990 (A Bibliography from the NTIS data base). Report for May 1970-February 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 90p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning gaseous and particulate contributions to the Earth's atmosphere from volcanoes, and the effects these substances have on the climate and the environment. Case studies of specific volcanic eruptions; detection and measurement of volcanic gases, aerosols, and particulates in the atmosphere; environmental effects on the biota; long and short term climatological effects; paleoclimatology and volcanoes; atmospheric and transport modelling; and solar radiation inhibition are among the topics discussed. (Contains 157 citations fully indexed and including a title list.)

33101 (PNL–6415-Rev.2) **Hanford Site National Environmental Policy Act (NEPA) characterization: Revision 2.** Cushing, C.E. (ed.). Pacific Northwest Lab., Richland, WA (USA). Dec 1989. 239p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90011056. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

This document describes the Hanford Site environment (Chapter 4.0) and contains data in Chapters 5.0 and 6.0 that will assist users in the preparation of National Environmental Policy Act-(NEPA-) related documents. It seemed necessary to prepare a consistent description of the Hanford Site environment to be used in preparing Chapter 4.0 of environmental impact statements and other site-related NEPA documentation. The material in Chapter 5.0 is a guide to the models used, including critical assumptions incorporated in these models, in previous Hanford NEPA documents. The user will have to select those models appropriate for the proposed action. Chapter 6.0 is essentially a definitive NEPA Chapter 6.0, which describes the applicable laws, regulations, and Doe and state orders. 140 refs., 23 figs., 34 tabs.

33102 (PNL–6450-30-HEDR) **Hanford Environmental Dose Reconstruction Project: Monthly report.** Dennis, B.S. (comp.). Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 65p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE90010835. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This monthly report summarizes the technical progress and project status for the Hanford Environmental Dose Reconstruction (HEDR) Project being conducted at Pacific Northwest Laboratory (PNL) under the direction of a Technical Steering Panel (TSP). The project is divided into the following technical tasks. These tasks address each of the primary steps in the path from radioactive releases to dose estimates: source terms, environmental transport, environmental monitoring data, demographics, agriculture, and food habits, and environmental pathways and dose estimates. The source terms task will develop estimates for radioactive emissions from Hanford facilities since 1944. These estimates will be based on historical measurements and production information. 1 fig., 1 tab.

33103 (UCRL–101735) **Climate Caucus report: Opportunities for bridging the gaps from effects to impacts.** MacCracken, M.C. Lawrence Livermore National Lab., CA (USA). Apr 1990. 10p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract W-7405-ENG-48. (CONF-8907191–1: Workshop on global climate change and its effects on California, Davis, CA (USA), 10-12 Jul 1989). Order Number DE90010877. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The workshop provided an important opportunity for those studying climate research to meet with those evaluating potential impacts as a bridge to formulating and developing effective policy responses. Participants identified an extensive range of capabilities at the University of California campuses and laboratories, spanning experience in biogeochemical cycling, atmospheric and oceanic modeling, data and model analysis and intercomparison, monitoring and observation capabilities, and hydrology and surface processes. These diverse capabilities together create a significant strength in study of our physical and chemical environment. Climate Caucus members identified a number of important initiatives that could extend understanding of potential changes in California. More detailed analysis of existing model simulations, model improvements including nesting of mesoscale models, and more extensive analyses of available data sets could provide important insights into potential changes in hydrology and in the intensity of the California current. Increased computer resources could provide both an incentive and the glue to enhance collaboration between physical and biological studies. A strong commitment to pursue these opportunities could assure significantly more definitive assessments of the potential impacts of climate change on California and provide a firmer basis for policy consideration.

33104 (UCRL–101997) **Numerical simulation of aerosol scavenging by ice-bearing convective clouds.** Bradley, M.M.; Molenkamp, C.R. Lawrence Livermore National Lab., CA (USA). Apr 1990. 3p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900796–1: American Meteorological Society conference on cloud physics, San Francisco, CA (USA), 23-27 Jul 1990). Order Number DE90010676. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Precipitation is the most effective mechanism for cleansing the atmosphere of small aerosol particles. Although there are many process paths by which precipitation can ultimately deposit aerosol on the ground, each path begins with the initial capture, or scavenging, of an aerosol particle. One of the most effective of these processes, at least in the absence of strong electric fields, is condensation nucleation scavenging, in which an aerosol particle serves as a cloud condensation nucleus. Although scavenging is a necessary precursor to aerosol removal by precipitation, scavenging does not guarantee that an aerosol particle will be removed from the atmosphere. For example, the particle will be resuspended if its host cloud droplet evaporates or if the droplet is collected by a raindrop which subsequently evaporates. The removal process becomes further complicated if ice is present in the cloud. The purpose of this research is to study the effects of various ice processes on the net aerosol removal efficiency of convective clouds. 8 refs.

33105 (UCRL–101998) **Parameterization of aerosol scavenging in a convective cloud model.** Molenkamp, C.R.; Bradley, M.M. Lawrence Livermore National Lab., CA (USA). Apr 1990. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900796–2: American Meteorological Society conference on cloud physics, San Francisco, CA (USA), 23-27 Jul 1990). Order Number DE90010865. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A three-dimensional numerical cloud model (OCTET) is developed to simulate the transport, diffusion and scavenging of aerosol particles. The initial purpose of the model is to estimate the fraction of smoke particles emitted by large fires that are scavenged by precipitation immediately above the fire and the fraction that is injected into the upper troposphere and stratosphere. Because large fires generate strong updrafts, the clouds penetrate above the freezing level and contain frozen hydrometeors; therefore, interactions of the aerosol with the ice phase must be included in the model. This paper is a description of the current microphysics and scavenging parameterization. 9 refs., 3 figs.

33106 (UCRL–102785) **Treatment and destruction of hazardous chemical wastes.** Ragaini, R.C. Lawrence Livermore National Lab., CA (USA). Feb 1990. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8902178–1: Treatment and destruction of hazardous chemical wastes, Erice (Italy), 8 Feb 1989). Order Number DE90010688. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This document discusses the issue of thermal incineration as it applies to two particular topics which are of interest. One topic is the treatment of mixed radioactive and hazardous waste, and the other topic, as was mentioned before, is the destruction of chemical munitions. The driving force that really affects the choice of treatment technology for both of these issues is a regulatory one. Specifically, in 1990, the United States Environmental Protection Agency (EPA) will complete the final phase of the Land Disposal Restriction (LDR) ban on the planned disposal of all untreated hazardous waste. In fact, EPA has been phasing in this regulation since 1986. Hazardous waste already banned from land disposal ranges from dioxins to heavy metals to PCBs and to halogenated organic compounds. And eventually, all waste designated by EPA as hazardous will be banned, and this amounts to about 450 materials, including all ignitable compounds, corrosives, reactives, and toxics.

33107 (UCRL-JC–103431) **A critical appraisal of model simulations.** MacCracken, M.C. Lawrence Livermore National Lab., CA (USA). Feb 1990. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-8905106–2: Workshop on greenhouse-gas induced climate change: a critical appraisal of simultations and observations, Amherst, MA (USA), 8-12 May 1989). Order Number DE90010694. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The complexity of the climate system and the absence of definitive analogs to the evolving climatic situation force use of theoretical models to project the future climatic influence of the

relatively rapid and on-going increase in the atmospheric concentrations of CO_2 and other trace gases. The most comprehensive of the available climate models are known as General Circulation Models (GCMs). These models represent what are believed to be the most important components of atmosphere, ocean, and cryosphere system relevant to determining the potential for an enhanced greenhouse effect. Two types of studies are performed to study the potential consequences of the increasing concentrations of greenhouse gases. In the first, the gas concentration (usually CO_2) is arbitrarily and instantaneously increased and the model is run until a new equilibrium climate is reached, the difference between the perturbed and control results being a measure of the sensitivity of the climate to the imposed perturbation. In the second type of simulation, the gas concentration is slowly increased as time advances. 1 tab.

33108 (UCRL-JC-103591) **A parametric investigation of electrical effects on aerosol scavenging by droplets over large fires.** Harvey, T.F.; Edwards, L.L. Lawrence Livermore National Lab., CA (USA). May 1990. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8910269--2: 8. annual meeting of the American Association for Aerosol Research, Reno, NV (USA), 10-13 Oct 1989). Order Number DE90010866. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Our nucleation model of strong up-drafts over large fires (such as those ignited by nuclear blasts) show that many droplets in the size range of 1 to 10 μm are rapidly formed when the cloud becomes supersaturated. In this study we calculate aerosol/droplet collection kernels for electrical parameters commonly seen in cloud air. These kernels are used with aged droplet distributions to determine instantaneous scavenging rates of unwettable aerosols with cloud droplets. We find that within a portion of this parameter space the aerosol may be removed from the cloud air with time constants substantially below 1-hour over the entire aerosol size range of .01 to 0.5μm. The aging of the droplet distribution incorporates the detailed microphysics of nucleation and condensation in a Lagrangian parcel with forces up-draft of 50 m/s. We assume an initial aerosol distribution that is lognormal about a median radius of 0.05μm with a geometric standard deviation of two. Initially there are 10^6 insoluble aerosol particles per cubic centimeter of air with one-half of them being wettable and the other half being non-wettable. We present our results as a set of curves showing collection kernels and instantaneous scavenging rates versus aerosol radius and electric field strengths. The collection kernel curves are parametrically displayed for droplets of radii 1-, 3-, and 10-μm and electrical parameters typical of cumulus and thunderstorm clouds. The instantaneous scavenging curve versus aerosol radius is displayed as a function of electrical parameters. 18 refs., 7 figs.

33109 (UCRL-JC-103969) **A preliminary evaluation of ADPIC [atmospheric diffusion particle-in-cell] model performance on selected ANATEX [Across North America Tracer Experiment] releases using observed, analyzed, and dynamically predicted winds.** Rodriguez, D.J.; Cederwall, R.T. Lawrence Livermore National Lab., CA (USA). May 1990. 9p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CONF-900534--1: 18. NATO/CCMS international technical meeting on air pollution modelling and its applications, Vancouver (Canada), 13-17 May 1990). Order Number DE90010638. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Work was undertaken to expand the domain of application of the mesoscale atmospheric diffusion particle-in-cell (ADPIC) model to the hemispheric scale. It was decided that the acquisition and software manipulation of large volumes of wind observations over continental or hemispheric scales would cause unacceptable delays in ARAC's response to an emergency situation. Consequently, arrangements were made to obtain processed fields of winds, which the Air Force Global Weather Central (GWC) produce on a routine basis. Until the recent release of the Across North America Tracer Experiment (ANATEX) database, there have been few opportunities for testing whether the GWC wind fields provide an accurate depiction of large-scale flow features between sources and samplers. The ANATEX database provides a fertile ground for testing the sensitivity and uncertainty of long-range models. The primary purpose of this paper is to focus on a single aspect of modeling uncertainty — the wind fields that describe the advection component of a transport and diffusion calculation. The ANATEX database has been used to evaluate the performance of ADPIC based on the use of wind-field products from three different sources: the GWC's Whole Mesh Grid covering the northern hemisphere, a more refined grid of advection velocities generated by in-house interpolative procedures applied to rawinsonde data and supplementary soundings in the source-receptor region, and dynamically consistent u, v and ω fields from the National Oceanic and Atmospheric Administration's Nested Grid Model. 7 refs., 4 figs.

33110 **Continuous emission monitoring of hazardous waste incinerators using Fourier transform infrared spectroscopy.** Demirgian, J.C. (Argonne National Lab., IL (USA). Analytical Chemistry Lab.); Erickson, M.D. 1-1 of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-890331--: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 630.

The testing of stack gas from hazardous waste incinerators is required under the Resource Conservation and Recovery Act (RCRA) both during trial burns and in on-going process monitoring. During the trial burn, the principal organic hazardous constituent (POHC) from the waste must be measured. Usually, either carbon tetrachloride or chloroform is selected as a POHC because each is difficult to incinerate. POHCs are sampled by a volatile organic sampling train (VOST) followed by laboratory analysis using thermal desorption gas chromatography/mass spectrometry (GC/MS). Results are typically available in 30 days. It has been demonstrated that, through the use of a combination of a variable path-length cell, Fourier transform infrared spectroscopy (FTIR), and analytical software, POHCs can be rapidly identified and measured quantitatively in stack gas. The entire process can be automated and results can be obtained in two minutes. This presentation illustrates the equipment and method, and gives results for the FTIR analysis of hazardous waste incinerators.

33111 **Radon-222, ^{222}Rn progeny, and ^{220}Rn progeny levels in 70 houses.** Dudney, C.S. (Oak Ridge National Lab., TN (USA)); Hawthorne, A.R.; Wallace, R.G.; Reed, R.P. *Health Physics (USA)*, 58(3): 297-311 (Mar 1990).

A year-long, multipollutant, indoor air quality study involving 70 occupied houses in four states was completed in 1987. All of the houses included in the study had a partial or complete basement with a concrete slab floor and block walls. On an approximately quarterly schedule, integrating monitors for short-lived Rn progeny, nitrogen dioxide, formaldehyde, and water vapor were exposed for 1 wk in each house on both the basement and main floors. At the beginning of the study, a pair of alpha-track detectors were placed on top of the refrigerator in the kitchen (or some other sampling location on the main floor) and at a location in the basement. One detector at each location was left in place for a year while the other detector was retrieved and replaced once every 3-mo period. In addition, short-term measurements of Rn and ^{222}Rn progeny were made at all sampling locations once per quarter. In this study, comparisons were made between: (1) seasonal and annual averages, (2) summer and winter averages, (3) living-area and basement results, (4) ^{222}Rn and ^{220}Rn progeny, and (5) short- and long-term measurements. The Rn and Rn progeny concentrations in houses near Huntsville, AL were found to be well above recommended action levels (150 Bq m-3). For houses near Birmingham, AL, summer Rn concentrations were found to exceed winter concentrations, whereas for the other houses in the study, winter concentrations exceeded summer concentrations. Potential alpha energy concentrations (PAEC) from ^{220}Rn progeny were found to be generally less than PAEC from ^{222}Rn.

33112 **Delay of explosive vaporization in pulsed laser-heated droplets.** Park, B. (New Mexico State University, Department of Physics, Las Cruces, New Mexico 88003 (USA)); Biswas, A.; Armstrong, R.; Pinnick, R.G. *Optics Letters (USA)*, 15(4): 206-208 (15 Feb 1990). 2025303.

Measurements of time delays for explosion of pulsed CO_2 laser-heated droplets are presented. A simple model based on classical nucleation theory in superheated liquids, which neglects heat and mass transport, is used to interpret the data. The model shows good agreement with the experimental observations.

33113 **Measurement of the deposition and fate of sulfur-dioxide-35 in a pine plantation.** Gay, D.W. (Savannah River Lab., Aiken, SC (USA)); Murphy, C.E. Jr. *Journal of Environmental Quality (USA)*, 18(3): 337-344 (Jul-Sep 1989).

An experiment was carried out to determine the uptake rate and fate of SO_2 absorbed by the forest canopy. The radioactive tracer, ^{35}S was used. Branches of loblolly pine were exposed to $^{35}SO_2$ in the field with a portable chamber. The exposed branches were excised and a sample of needles was immediately washed with distilled water. The needles and water collected in the field were analyzed for ^{35}S content. The results indicated that a portion of the ^{35}S could be washed from the needles and another portion was not removed with a water rinse. The portion that could not be removed by rinsing was absorbed at a rate and followed patterns of absorption, which suggested that absorption was controlled by stomatal diffusion, and thus was internal. The ^{35}S that could be removed by rinsing appeared to be surface absorption. The average deposition velocity for the entire leaf surface of the pine plantation was 0.0041 m/s. The distribution of ^{35}S was investigated by serial extractions. The fresh whole needles were rinsed in distilled water. Following rinsing, the dried and crushed leaf material was extracted with acetone, and then extracted with hexane. About 50% of the ^{35}S activity was removed by the water rinse. About one-third, 30 to 38%, of the ^{35}S activity remaining after washing was found in each of the two extracts and about one-third in the residual material left after extraction.

5402 Environmental Sciences, Terrestrial

Refer also to citation(s) 32099, 32102, 32103, 32105, 32152, 32155, 32156, 32158, 32159, 32161, 32202, 32209, 32215, 32221, 32222, 32241, 32268, 32309, 32446, 32447, 32809, 32974, 33035, 33055, 33057, 33062, 33075, 33101, 33102, 33146, 33147, 33163, 33169, 33177, 33187, 33276

33114 (ANL/ESH/TS–90/101) **Radiological oversight and certification report for the Lansdowne property, 105-107 East Stratford Avenue, Lansdowne, Pennsylvania, August 1988–June 1989.** Sholeen, C.M.; Munyon, M.J. Argonne National Lab., IL (USA). Environment, Safety, and Health Dept. Mar 1990. 323p. Sponsored by U.S. Department of Defense. DOE Contract W-31109-ENG-38. Order Number DE90010909. Available from NTIS, PC A15/MF A01 - OSTI; GPO Dep.

During the period 1920–1924, a University of Pennsylvania physics professor was engaged in the commercial production of radium sources for medical use in the basement of his home at 105 E. Stratford Avenue. As a result of the radium enrichment activities, the entire residence, the surrounding land, and the adjoining residence at 107 E. Stratford Avenue became contaminated. In August 1985, this site was officially added to the US Environmental Protection Agency's list of hazardous sites targeted for cleanup (Superfund). Argonne National Laboratory was asked to provide onsite radiological overview to the US Army Corps of Engineers for the remediation activities. The oversight activities included radiological surveying, laundry waste water sampling, air sampling and logging of contamination in the soil. Additional oversight responsibility included verification that the soil remaining on the site adjacent to the site and under the sewer line, as well as backfill soil, were below the cleanup criterion of 5pCi/g above the natural ^{226}Ra background level of 1.5 pCi/g. The exposure rate measurements from the restored site ranged from 8 to 11 μR/h, typical of the radiation background levels in this area. This report provides documentation of the oversight activities and verification that the cleanup criterion of 5 pCi/g ^{226}Ra above background has been met. 8 refs., 199 figs., 26 tabs.

33115 (ANL/ESH/TS–90/103) **Volume estimate of radium-contaminated soil in a section of Barrows Field Park, Glen Ridge, New Jersey, November–December 1989.** Robinet, M.J.; Mosho, G.D. Argonne National Lab., IL (USA). Environment, Safety, and Health Dept. Apr 1990. 76p. Sponsored by Environmental Protection Agency. DOE Contract W-31109-ENG-38. Order Number DE90011137. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

The objective of this project was to estimate the in-place volume of radium-contaminated soil in an area of Barrows Field Park, Glen Ridge, New Jersey. The information was necessary to determine whether or not there was sufficient soil with the proper radium concentration to test a new method of soil decontamination. The steps used by Argonne National Laboratory personnel to obtain the required data for estimating the volume of contaminated soil was to measure the contamination-depth profile at 118 locations in a 60 ft times 150 ft area in the park, plot the contours of depths to the specified concentration, and measure the area of the closed depth contours. 6 refs., 23 figs., 3 tabs.

33116 (BNL–43811-Rev.) **A perfluorocarbon tracer transport and dispersion experiment in the North Sea Ekofisk oil field: Revision.** Senum, G.I.; Dietz, R.N.; D'Ottavio, T.W.; Goodrich, R.W.; Cote, E.A.; Spandau, D.J. Brookhaven National Lab., Upton, NY (USA). Apr 1990. 74p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. Order Number DE90011000. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

A perfluorocarbon tracer (PFT) transport and dispersion experiment has been performed in the Ekofisk section of the North Sea Oil fields. Fifty grams each of three PFTs were injected into a well and 28 surrounding wells were sampled for the presence of PFT. Sampling was accomplished by initially collecting bottles of reservoir hydrocarbon gas and subsequently transferring 5 liter (gas phase) aliquots onto Capillary Adsorbent Tracer (CAT) samplers. The resulting CATS samplers were analyzed for PFT in a specially configured laboratory gas chromatograph with electron capture detection. Sampling was performed up to two years past the injection time. PFT was observed only in four sampling wells at four different times. The PFT concentrations observed in these four wells appeared to follow an exponential dilution law with a dilution half-life of approximately 70 days in the reservoir. 5 refs., 28 figs.

33117 (CEA-R–5494) **Ressac program plants analytical experiments study of a code modelling the soil to plant transfer factor of cesium.** Jouve, A.; Troesch, O.; Legrand, B. CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Oct 1989. 15p. (In French). Order Number DE90792948. Available from NTIS (US Sales Only), PC A03/MF A01.

The available data about the soil to plant transfer factor of cesium are numerous but very variable. The variation conditions of the transfer factor are studied with the help of laboratory experiments and the results analysed with the help of a multiple linear regression calculation. The results are applied to the soils and plants types the most frequently present around the French nuclear sites. A calculation model including the plant life conditions such as pH, water-soluble potassium and the available part of cesium in the water of the soil, is proposed. This model allows to predict the transfer factor with a better accuracy (up to ten times) than using the single ratio issue from the experimental data.

33118 (CONF-900724–3) **Transport studies of radon in limestone underlying houses.** Gammage, R.B.; Dudney, C.S.; Wilson, D.L.; Saultz, R.J. Oak Ridge National Lab., TN (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 5. international conference on indoor air quality and climate; Toronto (Canada); 29 Jul - 3 aug 1990. Order Number DE90009238. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

In hilly limestone terrains of the southern Appalachians, subterranean networks of solution cavities and fissures present circulatory systems facilitating convective and advective transport of radon-bearing gas. Evidence suggests that the primary driving forces for transport are aerostatic pressure differentials created by the difference between the underground and the outside air temperatures. Examples are presented of houses experiencing elevated indoor radon levels as a consequence of communicating with such subsurface transportation systems. The location of a house near the upper or lower end of a subterranean-circulatory system

seems to produce amplification of indoor radon levels in winter or summer, respectively. The transport mechanism for radon-bearing air in karst and its impact on indoor radon need better understanding, both in regard to evaluating the geographical prevalence of the phenomenon and the induced spatial and temporal effects that are possible. This paper reports field studies made at houses in karst regions at Oak Ridge, Tennessee, and Huntsville, Alabama. A primary radon-transport mechanism is advocated of ascending or descending subsurface columns of air whose flows are largely driven by aerostatic pressure gradients created by the inground-outdoor air temperature differentials. 5 refs., 5 figs., 1 tab.

33119 (CONF-900758–1) **Multilaboratory validation study of PCBs in soils using Soxtec® extraction technique (Method 3541).** Bayne, C.K.; Stewart, J.H. Jr. Oak Ridge National Lab., TN (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 2. annual envirACS exposition and 6th annual waste testing and quality assurance symposium; Washington, DC (USA); 17-19 Jul 1990. Order Number DE90010438. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Oak Ridge National Laboratory has evaluated a multilaboratory Soxtec PCB extraction study and has compiled the date from the eight participating laboratories. The experiment required each laboratory to extract PCB aroclor 1254 and 1260 from 10-g samples of Fuller's earth on 3 nonconsecutive days. Each sample was to be spiked at a concentration level of 5 ppm or 50 ppm. The average for all PCB percent recovery values is 88%, with a 95% confidence interval of (82%,93%). The estimated standard deviation for a single measurement within a laboratory is 19%. 2 refs., 2 tabs., 1 fig.

33120 (DOE/EH–0116) **Tiger Team environment, safety, and health assessment of the Kansas City Plant.** USDOE, Washington, DC (USA). May 1990. 344p. Sponsored by U.S. DOE Environment Health & Safety. Order Number DE90010293. Available from NTIS, PC A15/MF A01 - OSTI; GPO Dep.

This document contains the final findings identified during the Tiger Team Assessment of the US Department of Energy's (DOE's) Kansas City Plant (KCP) in Kansas City Missouri, conducted between November 6, 1989 and December 7, 1989. The scope of the assessment of KCP was comprehensive, covering areas of environment, safety, and health (ES&H) activities, including compliance with applicable Federal, state, and local regulations, requirements, permits, agreements, orders, consent decrees, and DOE ES&H Orders. In addition, the assessment included an evaluation of the adequacy and effectiveness of DOE and site contractor management, organization, and administration of the ES&H programs at KCP. 7 tabs.

33121 (DOE/EH–0126) **Tiger Team assessment of the Pinellas Plant.** USDOE Assistant Secretary for Environment, Safety and Health, Washington, DC (USA). May 1990. 399p. Sponsored by U.S. DOE Environment Health & Safety. Order Number DE90010294. Available from NTIS, PC A17/MF A01 - OSTI; GPO Dep.

This Document contains findings identified during the Tiger Team Compliance Assessment of the Department of Energy's (DOE's) Pinellas Plant, Pinellas County, Florida. The assessment wa directed by the Department's Office of Environment, Safety, and Health (ES&H) from January 15 to February 2, 1990. The Pinellas Tiger Team Compliance Assessment is comprehensive in scope. It covers the Environment Safety and Health, and Management areas and determines the plant's compliance with applicable Federal (including DOE), State, and local regulations and requirements.

33122 (DOE/ER–0432) **Subsurface Science Program: Program overview and research abstracts, FY 1989–FY 1990.** USDOE Office of Energy Research, Washington, DC (USA). Office of Health and Environmental Research. May 1990. 150p. Sponsored by U.S. DOE Energy Research. Order Number DE90010321. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The Subsurface Science Program, described in this document, supports an interdisciplinary university and national laboratory research program in geochemistry, microbiology, and hydrology. Long-term, fundamental research in subsurface science is critical to ensuring that new concepts for predicting environmental risk and facilitating cleanup are available in the future. The Subsurface Science Program is DOE's (Department of Energy) primary basic research program concerned with subsoils and groundwater. This document describes the core areas for fundamental research that have been identified thus far for priority research attention within the Subsurface Science Program. The fundamental research supported in each of these high-priority scientific areas is such that substantial resources have been concentrated on them for 3 to 5 years to ensure that scientific progress can be made. Although predicting the outcome of basic research is very difficult, selected goals for each subprogram that have been identified in consultation with investigators and the scientific community are included in this document. 17 figs., 5 tabs.

33123 (DPST–88-910) **Radionuclide uptake by pinetrees growing on lysimeters.** McIntyre, P.F.; Hawkins, R.H. Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab. 31 Oct 1988. 28p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90011251. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Radionuclide uptake of cesium and strontium by pine trees growing on defense waste lysimeters was previously measured between 1983 and 1985. Further sampling and analyses were performed during 1987 to determine if a change in radioactive uptake had occurred as a result of increased growth by the trees. Samples were taken from pine needles, woody stem portions and shallow rooted vegetation growing underneath each tree. In addition to ^{137}Cs and ^{90}Sr, several samples were analyzed for ^{14}C, ^{60}Co, ^{238}Pu, ^{239}Pu or ^{241}Am. 4 refs., 2 figs., 4 tabs.

33124 (EGG-CEMA–8185) **Integrated environmental monitoring at remote ecosystems: First annual report.** Bruns, D.A. (EG and G Idaho, Inc., Idaho Falls, ID (USA). Center for Environmental Monitoring and Assessment); O'Rourke, T.P.; Staley, C.S.; White, G.J.; Wiersma, G.B.; Baker, G.A.; Harmon, M.E.; Smith, B.G.; Clayton, J.L.; Greene, S.E. EG and G Idaho, Inc., Idaho Falls, ID (USA). Center for Environmental Monitoring and Assessment. Aug 1988. 221p. Sponsored by U.S. DOE Nuclear Energy; US Forestry Service. DOE Contract AC07-76ID01570. Order Number DE90010976. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

The first annual report reviews progress to date on the Idaho National Engineering Laboratory(INEL) research project,"Integrated Ecosystem and Pollutant Monitoring at Remote Wilderness Study Sites." The two primary objectives of this study are to apply, field test, and conceptually evaluate the US Forest Service guidelines for remote ecosystem monitoring and to provide an ongoing database on selected high-elevation ecosystem attributes, including physical, chemical, and biological parameters. The basic criteria for evaluation of the guidelines are usability, cost-effectiveness, data variability, alternative approaches, ecosystem conceptual approach, and quality assurance. The goal of the project is to identify a list of pollutant measurements and ecological attributes that will provide good, quality-assured data about a particular ecosystem. The present report covers each of the major components of the Forest Service guidelines except for regulatory and management constraints and visibility, which are not part of this project. Therefore, progress to date is provided as separate sections of the report for each of the following components: atomspheric environment, soils, aquatic chemistry, aquatic biology, salmonid fish, and plants (including forest ecosystem). 24 refs., 66 figs., 28 tabs.

33125 (EGG-ER–8686) **Summary of the 1987 soil sampling effort at the Idaho National Engineering Laboratory Test Reactor Area Paint Shop Ditch.** Wood, T.R.; Knight, J.L.; Hertzler, C.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). Aug 1989. 107p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90010978. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Sampling of the Test Reactor Area (TRA) Paint Shop Ditch at the Idaho National Engineering Laboratory was initiated in compliance with the Interim Agreement between the Department of Energy (DOE) and the Environmental Protection Agency (EPA). Sampling of the TRA Paint Shop Ditch was done as part of the Action Plan to achieve and maintain compliance with the Resource

Conservation and Recovery Act (RCRA) and applicable regulations. It is the purpose of this document to provide a summary of the July 6, 1987 sampling activities that occurred in ditch west of Building TRA-662, which housed the TRA Paint Shop in 1987. This report will give a narrative description of the field activities, locations of collected samples, discuss the sampling procedures and the chemical analyses. Also included in the scope of this report is to bring together data and reports on the TRA Paint Shop Ditch for archival purposes. 6 refs., 10 figs., 8 tabs.

33126 (GAO/RCED–90-6) **The coast guard's cleanup of hazardous waste sites.** Rezendes, V.S. General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div. Nov 1989. 20p. Available from US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877 (USA).

GAO concluded that the Coast Guard still has most of its major hazardous waste cleanup work to do - an effort that will cost millions and will take decades to complete. Yet the Coast Guard cannot confidently estimate long-term cleanup costs until it assesses and investigates potential hazardous waste locations. While Coast Guard data suggest that it is complying with hazardous waste regulations, this GAO report maintains that the Coast Guard may not be collecting the type of information needed to support long-term budget requests. The Coast Guard is planning to reissue reporting instructions in order to stress the importance of reporting violations and related costs. If successful, this effort could help ensure that the Coast Guard has the information necessary to estimate future funding needs.

33127 (GSF–9/89) **Report of an environmental radioactivity measurement campaign in the Schwandorf region, 1988.** Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Abt. fuer Technischen Strahlenschutz. May 1989. 99p. (In German). Order Number DE90792487. Available from NTIS (US Sales Only), PC A05/MF A01.

The measured results in some cases still reflect the effects of the Chernobyl reactor accident. Although the activity concentrations of Cs-134 and Cs-137 have diminished in almost all food samples, they still are higher than before Chernobyl. The level of activity concent ration varies in the different types of food and exhibits significant fluctuations depending on site of measurement and time.The high activity levels measured in milk in autumn 1986, going up to 26 and 58 Bq/l, respectively, the data measured in the Schwandorf region in spring 1987 were considerably lower again, and in 1988 remained on this lower level, ranging from 0.4 to 11 Bq/l. Local gamma activity measurements at 80 different measuring points in the period 1986 until 1988 show the following mean values: 1.01 mSv/a in 1986, 1.05 mSv/a in 1987, and 0.96 mSv/a in 1988. Judging from the data measured in the early 1960s, which reflect the overground nuclear weapons tests, it can be expected that Cs-134 and Cs-137 from the Chernobyl fallout will continue to contribute most to radioactivity levels in the environmental samples. (orig./HP).

33128 (IC–89/406) **The effects of rainfall energy on soil erosion in Southern Nigeria.** Adibe, E.C. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 14p. Order Number DE90627888. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Rainfall energy chosen as a satisfactory erosivity index in Southern Nigeria, was calculated for the period 1984-1988 for eleven autographic rainfall stations in the area. A highly significant relationship was obtained by relating the mean annual rainfall to the mean seasonal energy for the period. This new relationship (with $r = 0.98$) was used to calculate the mean seasonal energies from published mean annual amounts for 25 other stations in the area. Results show that mean seasonal energy in Southern Nigeria varies from 30435 J/m^2 to 116105 J/m^2. These energy values are higher in the south-eastern than in the south-western part of the country. The highest monthly energy values are in July and September (24.91% and 21.35% respectively of the total seasonal energy). Violent storms, especially in April, are particularly dangerous because most arable lands are bare and are being prepared for cultivation. Profiles of critical storms show that most of the rain falls in the first 30-60 minutes but a moderate rainfall may however last for another 3-5 hours. Based on the seasonal energy values, an isoerodent map which can be regarded as a good first approximation was prepared for Southern Nigeria. (author). 5 refs, 5 figs, 1 tab.

33129 (NAGRA-NTB–89-03) **Transmission electron microscopy study of illite/smectite mixed layers.** Meike, A. (Earth Science Board, California Univ., Santa Cruz (USA)). Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Apr 1989. 56p. Available from Nagra, CH-5401 Baden, Switzerland.

A transmission electron microscopy study was undertaken to investigate the microstructural relationships between mixed layer illite/smectite phyllosilicates and their alteration products. The analysis of specimens from Southwestern Sweden suggested that four types of montmorillonite alteration could be distinguished. The first three possibilities involved the dissolution of montmorillonite followed by the precipitation of various phases: silica, fine grained montmorillonite which subsequently recrystallized to illite, or quartz and illite. The fourth possibility involved dehydration and isostructural replacement of montmorillonite with illite. The mobility of amorphous silica in the montmorillonite structure was demonstrated using in-situ experiments with the electron beam, and static observations of two identical but differently prepared specimens. In the latter case distinctions were observed in the residence of the silica phase. Based on the transmission electron microscope observations, it is proposed that the precipitated amorphous silica can affect the swelling capability of monmorillonite both as a replacement of interlayer water, and as an obstruction to the free movement of water into the structure. (author) 2 tabs., 26 figs., 8 refs.

33130 (NIRS-R–17) **Final report on the Project Research 'Assessment of Human Exposure to Environmental Radiation': April 1983 - March 1988.** National Inst. of Radiological Sciences, Chiba (Japan). Mar 1989. 137p. (In Japanese). Order Number DE90791338. Available from NTIS (US Sales Only), PC A07/MF A01.

This is the final report of the Project Research, 'Assessment of Human Exposure to Environmental Radiation', which has been conducted during the period 1983-1988. With the objective of assessing risk of environmental radioactivity to the population, the Project was divided into the following five research groups: (1) research for establishing calculation models and parameters in transfer of radionuclides from crop species through the human body; (2) research for analyzing transfer of radionuclides in the ocean and their contributions to exposure doses in the human body; (3) research for surveying accuracy of exposure models for the external body and respiratory organ and the influential factors; (4) research for determining uptake and biokinetics of radionuclides in the body; and (5) research for estimating and evaluating physical and physiological characteristics of reference Japanese man and the populaltion doses. Effluents from nuclear power plants and reprocessing plants were regarded as radionuclide sources in the water and atmosphere. (N.K.).

33131 (NIRS-RSD–84) **Radioactivity survey data in Japan, part 1: Environmental materials.** National Inst. of Radiological Sciences, Chiba (Japan). Apr 1989. 23p. Order Number DE90791327. Available from NTIS (US Sales Only), PC A03/MF A01.

The report presents data obtained through a radioactivity survey. Various environmental and dietary materials are collected for analysis. Rain and dry fallout are collected monthly. Airborne dust is collected every three months. Service water samples are taken semiyearly. Freshwater is taken once a year (fishing season). Soil samples are taken once a year from two layers at different depths. Sea water is collected once a year at fixed stations where the effect of terrestrial fresh water from rivers is expected to be negligibly small. Sea sediments are collected once a year in the same area as that for the sea water sample. A full one day ordinary diet including three meals, water and tea for five persons is collected semiyearly as a sample of 'total diet'. Polished rice is collected in producing districts and in consuming areas. Raw milk is collected in producing districts and commercial milk is purchased in consuming districts. Vegetable are collected once a year in producing and consuming districts. Tea samples are also collected once a year.

Fish, shellfish and seaweeds are collected once a year. Test solutions are prepared from these samples. Strontium-90 and cesium-137 are separated and subjected to quantitative determination. Results obtained are tabulated. This part (Part 1) presents data on environmental materials. (N.K.).

33132 (PB–90-183799/XAB) **Forum on innovative hazardous-waste-treatment technologies: Domestic and international. Held in Atlanta, Georgia on Hune 19-21, 1989. Technical papers.** Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste and Emergency Response. Sep 1989. 328p. (EPA–540/2-89/056). Available from NTIS, PC A15/MF A02.

As a result of the high level of interest in innovative hazardous waste control technologies, U.S. EPA's Office of Solid Waste and Emergency Response and Risk Reduction Engineering Laboratory jointly conducted this conference. The conference consisted of presentations of technical papers and posters by international and domestic vendors of technologies for the treatment of waste, sludge, and contaminated soils at uncontrolled hazardous waste disposal sites. The purpose of the 2 1/2 day conference was twofold: to help introduce promising international technologies through technical paper and poster displays; and to showcase results of the U.S. EPA Superfund Innovative Technology Evaluation program technologies in addition to other domestic innovative technologies. Both were aimed at increasing awareness of the user community in technologies ready for application. The compendium does not include all papers that were presented; only those that were made available by authors and their institutions are included.

33133 (PB–90-862822/XAB) **Sludge dewatering: Sewage and industrial wastes. January 1978-December 1989 (A Bibliography from Pollution Abstracts). Report for January 1978-December 1989.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 109p. Available from NTISPC N01/MF N01.

Supersedes PB–89-861595.

This bibliography contains citations concerning techniques and equipment used in sewage, as well as industrial, mining, petroleum, and municipal-waste sludge dewatering. Dewatering processes, device design, and performance evaluations are considered. (This updated bibliography contains 266 citations, 12 of which are new entries to the previous edition.)

33134 (UCRL–21221) **Ozone and acid-precipitation on western coniferous forests.** Cowles, S.; Houpis, J.L.J.; Kercher, J.R. Lawrence Livermore National Lab., CA (USA). May 1990. 26p. Sponsored by Environmental Protection Agency. DOE Contract W-7405-ENG-48. Order Number DE90011014. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Reviews of airborne pollution problems and their effects on plants are numerous. The authors of these reviews integrate and synthesize the plethora of observations reported in the literature. In contrast, the focus here is a review of research into mechanistic processes. This brief literature review addresses the mechanistic effects of air pollutants on western coniferous forests in the United States and on the primary inhabitants of these forests. To accomplish this goal, literature from other regions was examined. This inclusion was necessary because most biological work examines the effects of air pollutants in the regions of heaviest impact, the eastern United States and Europe. The purpose of this review is to provide an introduction to various processes that have been identified as potentially important in relating air pollution to observed growth and metabolic changes. In particular, the mechanisms that are emphasized are those appropriate for inclusion in simulation models. 179 refs.

33135 (WHC-EP–0359) **North Slope investigation report.** Roos, R.C. Westinghouse Hanford Co., Richland, WA (USA). Apr 1990. 76p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-87RL10930. Order Number DE90010316. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The Department of Energy owns approximately 190 square miles of land north and east of the Columbia River (referred to as the "North Slope.") This land has not been used for production activities associated with the Hanford Site. Physical evidence does remain of use associated with military activities in the defense of the Hanford Site. The North Slope area was investigated between December 1989 and April 1990 to gather information on potential hazards that may exist. The investigation consisted of the following: review of historic records, interviews with people knowledgeable of the area, aerial search, and ground search. 1 ref., 2 figs.

33136 **Comparison of an unsaturated soil zone model (SESOIL) predictions with a laboratory leaching experiment.** Hetrick, D.M. (Computing and Telecommunications Div., Oak Ridge National Lab., Martin Marietta Energy Systems, Inc., Oak Ridge, TN (US)); Travis, C.C.; Kinerson, R.S. 807-814 of Proceedings of the 1988 winter simulation conference. Abrams, M.A.; Haigh, P.L.; Comfort, J.C. Society for Computer Simulation, San Diego, CA (USA) (1988). (CONF-881209–: 1988 winter simulation conference, San Diego, CA (USA), 12-14 Dec 1988).

Model predictions of a modified version of the soil compartment model SESOIL are compared with laboratory measurements of pollutant transport in soil. A brief description of SESOIL is given and modifications that have been made to the model are summarized. Comparisons are performed using data from a laboratory soil column study involving six chemicals (dicamba, 2,4-dichlorophenoxyacetic acid, atrazine, diazinon, pentachlorophenol, and lindane). Overall, SESOIL model predictions are in good agreement with the empirical data. Limitations of the model are discussed.

5403 Environmental Sciences, Aquatic

Refer also to citation(s) 32100, 32101, 32105, 32150, 32153, 32154, 32155, 32156, 32158, 32159, 32209, 32228, 32248, 32249, 32309, 32349, 32446, 32450, 32510, 33035, 33062, 33095, 33101, 33102, 33114, 33120, 33121, 33122, 33124, 33126, 33131, 33132, 33133, 33256

33137 (ANL–90/7) **Surveillance of Site A and Plot M report for 1989.** Golchert, N.W. Argonne National Lab., IL (USA). Apr 1990. 41p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. Order Number DE90010303. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The results of the environmental monitoring program conducted at Site A/Plot M in the Palos Park Forest Preserve area for CY 1989 are presented. The monitoring program is the ongoing remedial action that resulted from the 1976–1978 radiological characterization of the site. That study had determined that very low levels of hydrogen-3 migrated from the burial ground and was present in two nearby hand-pumped picnic wells. The current program consists of sample collection and analysis of air, surface and subsurface water, and bottom sediment. The results of the analyses are used to determine the migration pathway of water from the burial ground to the hand-pumped picnic wells, establish if buried radionuclides other than hydrogen-3 have migrated, and generally characterize the radiological environment of the area. 16 refs., 6 figs., 15 tabs.

33138 (CEA-R–5496) **Mechanisms of ^{60}Co uptake and loss by Scenedesmus obliquus and transfer to two benthic organisms.** Nucho, R. CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Oct 1989. 332p. (In French). Order Number DE90792947. Available from NTIS (US Sales Only), PC A15/MF A01.

The affinity of Scenedesmus obliquus for ^{60}Co has been confirmed under various experimental conditions allowing for the age of cultures, the physiological state of the cells, the radioactivity level and stable cobalt concentration in the medium, and the acute or periodic nature of the contamination. The dry weight ^{60}Co concentration factor may reach $4x10^4$ in LCO culture medium and is about 10^4 in natural water. ^{60}Co uptake by algae is a 95% passive phenomenon, initiated by radionuclide absorption on the cell walls and followed by intracellular diffusion in accordance with Fick's law. From the initial cationic form, radiocobalt develops anion forms at a rate proportional to the algal biomass, resulting in lower contamination of old and dense cultures. After transfer in natural or artificial nonradioctive medium, ^{60}Co is eliminated by Scenedesmus

obliquus, mainly as Co^{2+} ions, according to a two-phase exponential process with two biological half-lives. The study of radioactive cobalt transfer from algae to gammarids and to midge larvae reveals the extend to which phytoplankton predominate over water and sediment in contaminating these two organisms. The total ^{60}Co uptake depends significantly on whether the cells are incorporated in or deposited on the sediment. No biomagnification phenomenon of the radionuclide was found in any case, as the transfer factor was less than 1. Depuration of ^{60}Co by organisms involved a two-phase exponential process regardless of whether uptake occured directly or from food. The presence of sediment appears to reduce the ^{60}Co desorption rate, but from 85 to 95% of the initial quantity is eliminated. This percentage does not depend on the transfer pathway or the presence of organic matter, and indicates very slight assimilation of radiocobalt ingested with algal cells.

33139 (CONF-9004197–1) **Evaluating direct toxicity and food-chain effects in aquatic systems using natural periphyton communities.** Boston, H.L.; Hill, W.R.; Stewart, A.J. Oak Ridge National Lab., TN (USA). [1990]. 39p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. From 2. symposium on use of plants for toxicity assessment; San Francisco, CA (USA); 23-24 Apr 1990. Order Number DE90011063. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Periphytic algae are a ubiquitous and ecologically important component of many rivers and streams and are useful for assessing toxicity. We studied periphyton communities in several streams near Oak Ridge National Laboratory in Tennessee as part of a biological monitoring program. Periphyton was used to identify stream reaches with ambient toxicity, characterize conditions for the growth of periphyton and other aquatic biota, and evaluate contaminant transport and toxicity through food-chain interactions. 37 refs., 6 figs., 4 tabs.

33140 (DOE/ER/60664–5) **A unified theory of radon transport in porous media: Model benchmark and soil parameter evaluations: Project annual report.** Nielson, K.K.; Rogers, V.C.; Bollenbacher, M.K. Rogers and Associates Engineering Corp., Salt Lake City, UT (USA). Apr 1990. 67p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER60664. (RAE–8810-6). Order Number DE90011418. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report documents the activities by Rogers and Associates Engineering Corporation personnel in the second year of a grant from the Office of Health and Environmental Research at the US Department of Energy. The project objective is to integrate theories of all significant radon generation and transport mechanisms into a unified, self-consistent theory. During the second year of the project, the following activities were performed. Several field permeabilities were measured to develop a soils data base for a simple permeability correlation. Simple soil gas permeability and radon diffusion coefficient correlations were developed from the RAE data base. A methodology was developed to characterize the air permeabilities and radon diffusion coefficients of soils in general, and the Soil Conservation Service soil classifications in particular. The RAETRAN code was benchmarked against two different sets of measurements. Using RAETRAD, a multidimensional code that was developed with internal funds, the radon source/receptor coupling characteristics were investigated. Several important trends are identified. 76 refs., 19 figs., 5 tabs.

33141 (GAO/RCED–89-144) **Air pollution: EPA's ambient air policy results in additional pollution.** General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div. Aug 1989. 28p. Available from US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877 (USA).

Air above company-controlled property is not considered ambient air and is exempted by EPA from meeting Clean Air Act requirements for six widespread pollutants. This paper presents a GAO report on this EPA policy which was adopted to allow flexibility in implementing the act and to allow certain industries to continue operations. This policy has been stretched as some sources have been allowed to increase emissions by acquiring additional land where violations of ambient air quality standards had been recorded and restricting public access to it. EPA's guidelines on the use of air quality models need to be applied consistently to assure fair and uniform treatment of entities being regulated. Noncompliance with EPA's recommended modeling policies and procedures may have resulted in the approval of high emission limits than would have otherwise been approved.

33142 (PB–90-137100/XAB) **Health assessment for Beachwood Borough and Berkeley Township National Priorities List (NPL) Site, Ocean County, New Jersey, Region 2. CERCLIS No. NJD980654123. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 17 Apr 1989. 14p. Available from NTIS, PC A03/MF A01.

The Beachwood Borough and Berkeley Township National Priorities List (NPL) Site is located in Ocean County, New Jersey. A portion of the nearby population is exposed to generally low to moderately high levels of lead, copper, and manganese contamination by the ingestion of water. The sources of manganese are still under question and further sampling is required to define these sources. Lead and copper levels are most likely related to the naturally occurring acidic and corrosive groundwaters which leach the metals from the household plumbing, and in certain instances, the serving wells. Currently, there appears to be a small segment of the area population that may be exposed to moderately high concentrations of lead in their potable water (0.7 mg/l). Lead contamination of potable water supplies is of public health concern. High concentrations of manganese may have health implications. The manganese concentrations that were found (0.617 mg/l maximum) relate mainly to the aesthetic qualities of the water rather than to public health.

33143 (PB–90-159971/XAB) **Long-term benthic monitoring studies in the freshwater portion of the Potomac River: 1983 to 1985, cumulative report. Volume 1. Text.** Shaughnessy, A.T.; Holland, A.F. Versar, Inc., Columbia, MD (USA). Dec 1989. 237p. Available from NTIS, PC A11/MF A02.

See also Volume 2, PB–90-159989.

The report summarizes data from the first three years of a long-term monitoring program to establish baseline conditions in benthic communities on the upper Potomac River. Major sources of variation were considered in an effort to characterize the effect of two power plants on distribution and abundance of the benthos. Distinct changes occurred in benthic communities in the vicinity of power plant discharges. These included decreased abundances of dominant species and reduced occurrences of rare species. Impacts associated with power plants were most severe during summer months and during low flow years.

33144 (PB–90-159989/XAB) **Long-term benthic monitoring studies in the freshwater portion of the Potomac River: 1983 to 1985, cumulative report. Volume 2. Appendices.** Shaughnessy, A.T.; Holland, A.F. Versar, Inc., Columbia, MD (USA). Dec 1989. 361p. Available from NTIS, PC A16/MF A02.

See also Volume 1, PB–90-159971.

The report summarizes data from the first three years of a long-term monitoring program to establish baseline conditions in benthic communities on the upper Potomac River. Major sources of variation were considered in an effort to characterize the effect of two power plants on distribution and abundance of the benthos. Distinct changes occurred in benthic communities in the vicinity of power plant discharges. These included decreased abundances of dominant species and reduced occurrences of rare species. Impacts associated with power plants were most severe during summer months and during low flow years.

33145 (PB–90-173857/XAB) **Determination of heavy metals on the Rock River through the analysis of sediments.** Landsberger, S.; Hopke, P.K.; Golchert, B. Illinois Univ., Urbana, IL (USA). Jan 1990. 47p. Available from NTIS, PC A03/MF A01.

Neutron-activation analysis has been used to analyze sediment cores from the Rock River and two branches of Kent Creek, one of its tributaries, to determine the concentrations of thirteen heavy metals (Ti, Cu, V, Mn, As, Sb, Se, Cr, Ni, Sc, Fe, Zn, and Co) and two rare earths (Sm and La). The downstream sites of both the Rock River and the two branches of Kent Creek have elevated concentrations of several heavy metals including arsenic, antimony, and zinc. In addition, hundreds of parts per million of copper have been found in samples from the downstream site of the North Fork

of Kent Creek. Toxicity tests of the sediments also indicate that the downstream sites are detrimental to lifeforms. Analyses of the data from the two branches of Kent Creek clearly indicate that heavy-metal concentrations increase as the distance from the center of industrial activity (Rockford) decreases.

33146 (PB–90-178039/XAB) **Superfund Record of Decision (EPA Region 6): Motco Superfund Site, La Marque, Texas (second remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 27 Sep 1989. 118p. (EPA/ROD/R–06-89/052). Available from NTIS, PC A06/MF A01.

Portions of this document are not fully legible.

The 11-acre Motco site is in La Marque, Galveston County, Texas. Pits were used by a styrene tar recycling business which operated from 1959 to 1961, and by an industrial chemical waste disposal facility from 1961 to 1968. In 1984 an initial remedial measure (IRM) was conducted by EPA and included removal and offsite disposal of wastes from nine above ground storage tanks. The first operable unit for the site was issued in 1985 and dealt with source control measures including excavation of the onsite waste pits, which contained 12 million gallons of contaminated water and organic liquids, down to the sludge/soil interface plus one foot, and incineration of those wastes. The Record of Decision represents the second and final operable unit, management of migration, for the site and addresses the subsurface beneath the waste pits and offsite contamination of the ground water, soil, and sediment. Ground water at the site is found in a Transmissive Zone and the underlying Upper Chicot aquifer. The primary contaminants of concern affecting the soil, sediment, and ground water are VOCs including benzene; other organics including PAHs; and metals including arsenic, chromium, and lead.

33147 (PB–90-178120/XAB) **Superfund Record of Decision (EPA Region 5): Ionia City Landfill, Ionia, Michigan (First remedial action, September 1989).** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 60p. (EPA/ROD/R–05-89/105). Available from NTIS, PC A04/MF A01.

The Ionia City Landfill site is a 20-acre municipally owned landfill in the southeast corner of Ionia, Michigan. The landfill was operated from the 1950s until about 1969, during which time industrial, commercial, and municipal wastes were disposed of at the site, including drummed liquids and solids from industrial sources. Drums of ignitable liquid wastes were reportedly burned until 1965. A State investigation in 1981 revealed exposed drums containing paint wastes, thinners, and industrial solvents as well as elevated levels of metals. Furthermore VOC- and metal-contaminated ground water was detected. EPA investigations began in 1982 and revealed VOC contamination in the Grand River tributary surface water. The primary contaminants of concern affecting the soil and debris are VOCs including vinyl chloride and methyl chloride, other organics, and metals including chromium.

33148 (PB–90-181306/XAB) **Dechlorination of pentachlorophenol, 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid in anaerobic freshwater sediments.** Bryant, F.O.; Rogers, J.E. Environmental Protection Agency, Athens, GA (USA). Environmental Research Lab. Feb 1990. 16p. (EPA–600/M-90/006). Available from NTIS, PC A03/MF A01.

Pentachlorophenol, 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid were transformed by microbial reductive dechlorination in freshwater, anaerobic sediments from such diverse locations as Georgia, Florida, New York and the Soviet Union. The reductive dechlorination process involves removal of a chlorine and replacement with a hydrogen. Sediments previously adapted to dechlorinate dichlorophenols were found to mediate dechlorination at much faster rates than unadapted sediments. Pentachlorophenol dechlorination in dichlorophenol-adapted sediments generated tetra-, tri-, di-, and monochlorophenol and phenol. Concentrations of pentachlorophenol, 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid up to 100 ppm were dechlorinated by adapted sediments. Reductive dechlorination of PCP, 2,4-D, and 2,4,5-T was region specific for chlorine removal as determined by the dichlorophenol isomer used to adapt the sediment. Sediment adapted to 2,4-dichlorophenol preferentially removed chlorines from the ortho position; whereas sediment adapted to 3,4-dichlorophenol preferentially removed chlorines from the para position.

33149 (PB–90-181314/XAB) **Oasis: Parameter estimation system for aquifer-restoration models. User's manual. Version 2.0. Report for October 1987-September 1989.** Newell, C.J.; Haasbeek, J.F.; Hopkins, L.P.; Alder-Schaller, S.E.; Rifai, H.S. Rice Univ., Houston, TX (USA). Dept. of Environmental Sciences and Engineering. Feb 1990. 59p. Available from NTIS, PC A04/MF A01.

See also PB–89-151112 and PB–89-151120.

OASIS, a decision support system for ground water contaminant modeling, has been developed for the EPA by Rice University, through the National Center for Ground Water Research. As a decision support system, OASIS was designed to provide a set of tools which will help scientists and modelers assess ground water contamination problems. OASIS is a graphical decision support system and was developed around BIOPLUME II, a numerical model which simulates the aerobic degradation of dissolved hydrocarbons in ground water. The OASIS system was developed in the HyperCard environment and, unlike traditional software, contains extensive documentation and help onscreen. Question mark icons throughout OASIS lead the user to further discussion and definitions, thereby allowing the system to be fully operational without the aid of paper documentation. The information in OASIS includes documentation, a hydrogeologic database, two chemical databases, several simple hydrogeologic models, and the BIOPLUME II model with preprocessors and postprocessors. The system was developed for use on Macintosh personal computers and now contains over 1600 screens and 9 megabytes of information.

33150 (PB–90-181330/XAB) **Proximity of Pennsylvania sanitary landfills to wetlands and deepwater habitats: Data on individual landfills.** Herndon, R.C.; Moerlins, J.E.; Lambou, V.W.; Gebhard, R.L. Florida State Univ., Tallahassee, FL (USA). Center for Biomedical and Toxicological Research and Hazardous Waste Management. Dec 1989. 36p. Available from NTIS, PC A03/MF A01.

See also PB–90-153511.

Sanitary landfills can cause considerable harm to sensitive ecosystems if they are not properly located, designed, and managed. The purpose of the reports is to summarize the proximity of sanitary landfills in Pennsylvania to wetlands and deepwater habitats (i.e., rivers, lakes, streams, bays, etc.) and present data on the individual landfills. The sanitary landfills were identified on U.S. Fish and Wildlife Service's National Wetlands Inventory maps. The nearness or proximity of the sanitary landfills to wetlands and deepwater habitats was determined by drawing three concentric regions around the point representing the location of each landfill. The radii of the concentric regions were: 1/4 mile, 1/2 mile, and 1 mile. Most sanitary landfills in Pennsylvania are located in or are close to either wetlands or deepwater habitats. Most are located close to wetlands while almost half are close to deepwater habitats. These facilities have the potential to adversely affect sensitive ecosystems, such as wetlands and deepwater habitats, either through habitat alterations or through the migration of contaminants from sanitary landfills.

33151 (PB–90-181355/XAB) **Proximity of Delaware sanitary landfills to wetlands and deepwater habitats: Data on individual landfills. Part B.** Gebhard, R.L.; Herndon, R.C.; Moerlins, J.E.; Lambou, V.W. Florida State Univ., Tallahassee, FL (USA). Center for Biomedical and Toxicological Research and Hazardous Waste Management. Nov 1989. 17p. Available from NTIS, PC A03/MF A01.

See also PB–90-163585.

Sanitary landfills can cause considerable harm to sensitive ecosystems if they are not properly located, designed, and managed. The purpose of the reports is to summarize the proximity of sanitary landfills in Delaware to wetlands and deepwater habitats (i.e., rivers, lakes, streams, bays, etc.) and present data on the individual landfills. The sanitary landfills were identified on U.S. Fish and Wildlife Service's National Wetlands Inventory maps. The nearness or proximity of the sanitary landfills to wetlands and

deepwater habitats was determined by drawing three concentric regions around the point representing the location of each landfill. The radii of the concentric regions were: 1/4 mile, 1/2 mile, and 1 mile. All sanitary landfills in Delaware are located in or are close to either wetlands or deepwater habitats. These facilities have the potential to adversely affect sensitive ecosystems, such as wetlands and deepwater habitats, either through habitat alterations or through the migration of contaminants from sanitary landfills.

33152 (PB–90-181868/XAB) **Computerized data-base system for land-use and land-cover data collected at ground-water sampling sites in the pilot National Water-Quality Assessment Program. Water-Resources Investigation.** Scott, J.C. Geological Survey, Oklahoma City, OK (USA). Water Resources Div. 1989. 148p. (USGS/WRI–89-4172). Available from NTIS, PC A07/MF A01.

Also available from Supt. of Docs.

Data-base software has been developed for the management of land-use and land-cover data collected by the U.S. Geological Survey as part of a pilot program to test and refine concepts for a National Water-Quality Assessment Program. The report describes the purpose, use, and design of the land-use and land-cover data-base software. The software provides capabilities for interactive storage and retrieval of land-use and land-cover data collected at ground water sampling sites. Users of the software can add, update, and delete land-use and land-cover data. The software also provides capabilities to group, print, and summarize the data. The land-use and land-cover data-base software supports multiple data-base systems so that data can be accessed by persons in different offices. Data-base systems are organized in a tiered structure. Each data-base system contains all the data stored in the data-base systems located in lower tiers of the structure. Data can be readily transmitted from lower tiers to higher tiers of the structure. Therefore, the data-base system at the highest tier of the structure contains land-use and land-cover data for the entire pilot program.

33153 (PB–90-181959/XAB) **Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point-source category.** Environmental Protection Agency, Washington, DC (USA). Industrial Technology Div. May 1989. 5397p. Available from NTIS, PC EE99/MF E99.

Set includes PB–90-181967 through PB–90-182056. See also PB–87-121752.

A separate abstract is included for each of the 10 volumes of this set.

33154 (PB–90-181967/XAB) **Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 1. General. Final report.** Environmental Protection Agency, Washington, DC (USA). Industrial Technology Div. May 1989. 509p. (EPA–440/1-89/019.1). Available from NTIS, PC A22/MF A03.

See also PB–87-121752 and Volume 2, PB–90-181975; Also available in set of 10 reports PC E99/MF E99, PB–90-181959.

The United States Environmental Protection Agency (EPA) has promulgated effluent limitations and standards for the nonferrous metals manufacturing category pursuant to Sections 301, 304, 306, 307, and 501 of the Clean Water Act. The promulgated regulation contains effluent limitations for best practicable control technology currently available (BPT), and best available technology economically achievable (BAT), as well as pretreatment standards for new and existing sources (PSNS and PSES), and new source performance standards (NSPS). This development document presents the technical summary of EPA's study of the nonferrous-metals-manufacturing category. The volume summarizes the general findings of the study, while the remaining volumes contain supplements that detail specific results for each subcategory.

33155 (PB–90-181975/XAB) **Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 2. Bauxite refining, primary aluminum smelting, secondary aluminum smelting. Final report.** Environmental Protection Agency, Washington, DC (USA). Industrial Technology Div. May 1989. 497p. (EPA–440/1-89/019.2). Available from NTIS, PC A21/MF A03.

See also PB–87-121752 and Volume 1, PB–90-181967 and Volume 3, PB–90-181983; Also available in set of 10 reports PC E99/MF E99, PB–90-181959.

Contents include: industry profile; subcategorization; water use and wastewater characteristics; selection of pollutant parameters; control and treatment technologies; costs of waste water treatment and control; best practicable technology currently available; best available technology economically achievable; new source performance standards; pretreatment standards; best conventional pollutant-control technology.

33156 (PB–90-181983/XAB) **Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 3. Primary copper smelting, primary electrolytic copper refining, secondary copper, metallurgical acid plants. Final report.** Environmental Protection Agency, Washington, DC (USA). Industrial Technology Div. May 1989. 385p. (EPA–440/1-89/019.3). Available from NTIS, PC A17/MF A03.

See also PB–87-121752 and Volume 2, PB–90-181975 and Volume 4, PB–90-181991; Also available in set of 10 reports PC E99/MF E99, PB–90-181959.

Table of contents include: Subcategory profile; Subcategorization; Water use and wastewater characteristics; Selection of pollutant parameters; Control and treatment technologies; Costs, energy, and nonwater-quality aspects; Best practicable technology currently available; Best available technology economically achievable; New source performance standards technical approach to BDT; Pretreatment standards; Best conventional pollution-control technology.

33157 (PB–90-181991/XAB) **Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 4. Primary zinc, primary lead, secondary lead, primary antimony. Final report.** Environmental Protection Agency, Washington, DC (USA). Industrial Technology Div. May 1989. 657p. (EPA–440/1-89/019.4). Available from NTIS, PC A99/MF A04.

See also PB–87-121752 Volume 3, PB–90-181983 and Volume 5, PB–90-182007; Also available in set of 10 reports PC E99/MF E99, PB–90-181959.

Contents include: industry profile; subcategorization; water use and wastewater characteristics; selection of pollutant parameters; control and treatment technologies; costs, energy, and nonwater-quality aspects; best practicable technology currently available; best available technology economically achievable; new source performance standards; pretreatment standards; best conventional pollutant-control technology.

33158 (PB–90-182007/XAB) **Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 5. Primary precious metals and mercury, secondary precious metals, secondary silver, secondary mercury. Final report.** Environmental Protection Agency, Washington, DC (USA). Industrial Technology Div. May 1989. 764p. (EPA–440/1-019.5). Available from NTIS, PC A99/MF A04.

See also PB–87-121752 and Volume 4, PB–90-181991 and Volume 6, PB–90-182015; Also available in set of 10 reports PC E99/MF E99, PB–90-181959.

Contents include: subcategory profile; subcategorization; water use and waste water characteristics; selection of pollutant parameters; control and treatment technologies; costs, energy, and nonwater-quality aspects; best practicable control technology current available; best available technology economically achievable; new source performance standards; pretreatment standards; best conventional pollutant-control technology.

33159 (PB–90-182015/XAB) **Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 6. Primary tungsten, secondary tungsten and cobalt, primary molybdenum and rhenium, secondary molybdenum and vanadium. Final report.** Environmental Protection Agency,

Washington, DC (USA). Industrial Technology Div. May 1989. 649p. (EPA–440/1-89/019.6). Available from NTIS, PC A99/MF A04.

See also PB–87-121752 and Volume 5, PB–90-182007 and Volume 7, PB–90-182023; Also available in set of 10 reports PC E99/MF E99, PB–90-181959.

Contents include: subcategory profile; subcategorization; water use and waste water characteristics; selection of pollutant parameters; control and treatment technologies; costs, energy, and nonwater quality aspects; best practicable technology currently available, best available technology economically; new source performance standards; pretreatment standards; best conventional pollutant-control technology.

33160 (PB–90-182023/XAB) **Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 7. Primary beryllium, primary nickel and cobalt, secondary nickel, secondary tin. Final report.** Environmental Protection Agency, Washington, DC (USA). Industrial Technology Div. May 1989. 692p. (EPA–440/1-88/019.7). Available from NTIS, PC A99/MF A04.

See also PB–87-121752 and Volume 6, PB–90-182015 and Volume 8, PB–90-182031; Also available in set of 10 reports PC E99/MF E99, PB–90-181959.

Contents include: subcategory profile; subcategorization; water use and waste water characteristics; selection of pollutant parameters; control and treatment technologies; costs, energy, and nonwater-quality aspects; best practicable control technology currently available; best available technology economically achievable; pretreatment standards; best conventional pollutant-control technology.

33161 (PB–90-182049/XAB) **Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 9. Primary and secondary titanium, primary zirconium and hafnium. Final report.** Environmental Protection Agency, Washington, DC (USA). Industrial Technology Div. May 1989. 422p. (EPA–440/1-89/019.9). Available from NTIS, PC A18/MF A03.

See also PB–87-121752 and Volume 8, PB–90-182031 and Volume 10, PB–90-182056; Also available in set of 10 reports PC E99/MF E99, PB–90-181959.

Contents include: subcategory profile; subcategorization; selection of pollutant parameters; control and treatment technologies; costs, energy, and nonwater-quality aspects; best practicable control technology currently available; best available technology economically achievable; new source performance standards; pretreatment standards; best conventional pollutant-control technology.

33162 (PB–90-182056/XAB) **Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 10. Primary and secondary germanium and gallium, primary rare earth metals, secondary indium. Index. Final report.** Environmental Protection Agency, Washington, DC (USA). Industrial Technology Div. May 1989. 353p. (EPA–440/1-89/019.10). Available from NTIS, PC A16/MF A02.

See also PB–87-121752 and Volume 9, PB–90-182049; Also available in set of 10 reports PC E99/MF E99, PB–90-181959.

Contents include: subcategory profile; subcategorization; water use and wastewater characteristics; selection of pollutant parameters; control and treatment technologies; costs, energy, and nonwater-quality aspects; best practicable control technology currently available; best available technology economically achievable; new source performance standards; pretreatment standards; best conventional pollutant-control technology.

33163 (PB–90-182486/XAB) **Description of Risk Reduction Engineering Laboratory: Test and evaluation facilities.** Environmental Protection Agency, Cincinnati, OH (USA). Risk Reduction Engineering Lab. Jun 1989. 20p. (EPA–600/M-89/002). Available from NTIS, PC A03/MF A01.

The brochure is an overview of the test and evaluation facilities of the Cincinnati based Risk Reduction Engineering Laboratory (RREL), Office of Research and Development, U.S. EPA. While these facilities and capabilities vary greatly as to function and scope they have in common their abilities to serve the scientific and engineering needs of RREL client offices, both within EPA, and for other Federal, State and local organizations, and industry. Detailed information regarding permitted wastes and unit processes, for each facility location, is included. The facilities described are: Cincinnati (Ohio area) – (test and evaluation facility, center hill facility, full containment facility, drinking water pilot plant (fixed and mobile), mobile wastewater treatment units, and mobile dehalogenation treatment units); Jefferson (Arkansas) – (combustion research facility); Edison (New Jersey) – Synthetic Soils Matrix (SSM) blending facility, underground storage tank test apparatus, environmental technology and engineering (E-TEC) facility. RREL facilities are available to industry, academia, and other governmental agencies to pursue cooperative treatability studies or process control, and equipment research and development activities under the Stevenson-Wydler Technology Innovation Act as amended by the Federal Technology Transfer Act of 1986.

33164 (PB–90-182726/XAB) **Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the Salton Sea Area, California, 1986-87. Water-Resources Investigation.** Setmire, J.G.; Wolfe, J.C.; Stroud, R.K. Geological Survey, Sacramento, CA (USA). Water Resources Div. 1990. 76p. (USGS/WRI–89-4102). Available from NTIS, PC A05/MF A01.

Water, bottom sediment, and biota were sampled during 1986-87 in the Salton Sea area to determine concentrations of trace elements and pesticides as part of the Department of Interior Irrigation Drainage Program. The sampling sites (12 water, 15 bottom sediment, and 5 biota) were located in the Coachella and Imperial Valleys. The focus of sampling was to determine if contaminants in irrigation drainage from Department of the Interior-sponsored irrigation projects have caused or have the potential to cause substantial harmful effects to humans, fish, or wildlife, or to reduce the suitability of water for beneficial uses. Results indicate that selenium is the major element of concern. Elevated concentrations of selenium in water were restricted to tile-drain effluent. The maximum selenium concentration of 300 micrograms per liter was detected in tile drain 6, and the minimum concentration of 1 microgram per liter was detected in a composite sample of Salton Sea water. The median selenium concentration was 19 micrograms per liter. In contrast to the water, the highest bottom-sediment selenium concentration of 3.3 milligrams per kilogram was in a composite sample from the Salton Sea. Concentrations of boron, chromium, nickel, zinc, and organochlorine pesticide residues were detected.

33165 (PB–90-183369/XAB) **Economic impact study of landfill regulations (R88-7). Final report.** Pferdehirt, W.; Frank, J.; Lance, R.; Becker, J.F. Camp Dresser and McKee, Inc., Chicago, IL (USA). Jan 1990. 468p. Available from NTIS, PC A20/MF A03.

The Economic Impact Study (EcIS) addresses the expected economic impact of new landfill regulations, regulatory docket R88-7, under consideration for adoption as State environmental laws by the Illinois Pollution Control Board. The proposed solid-waste rules will have significant cost impacts to owners/operators of many current as well as future landfill sites in Illinois. because the new regulations will impose greater design, operating, and reporting standards relative to existing solid-waste rules. Further, these cost impacts could affect such factors as the size and ownership distribution of Illinois' overall landfill disposal system. In contrast to these cost impacts, specific benefits will also be generated from the Board's proposed rulemaking. These benefits principally occur from the avoided future costs of ground-water remediation. The proposed regulations would decrease the potential for ground-water contamination at landfills by reducing the expected generation of leachate, requiring leachate to be collected and treated, providing increased monitoring of ground-water quality, and providing clearly defined standards under which the Illinois Environmental Protection Agency can require remedial investigations and cleanup prior to the migration of contaminants beyond the landfill site.

33166 (PB–90-183583/XAB) **Evaluation of ground-water extraction remedies. Volume 1. Summary report.** CH2M Hill Southeast, Inc., Reston, VA (USA). Sep 1989. 66p. Available from NTIS, PC A04/MF A01.

Also available from Supt. of Docs.

Ground water extraction is the most commonly used remedial technology for contaminated aquifers. In this investigation, information is assembled from hazardous waste sites throughout the United States showing how ground-water extraction systems are being used, how their performance compares with expectations, and what factors are affecting their success.

33167 (PB–90-184268/XAB) **Molycorp Guadalupe Mountain tailings disposal facility. Final report.** Bureau of Land Management, Albuquerque, NM (USA). Nov 1989. 527p. Available from NTIS, PC A23/MF A03.

Also available from Supt. of Docs.

Molycorp proposes to construct and operate a molybdenum tailings disposal facility on 1,230 acres of public land near Questa, New Mexico and has located mill site claims for this purpose. The project would consist of a 568-acre tailings pond in the saddle of Guadalupe Mountain. The pond would be formed by the construction of two rock-filled dams at either end of the saddle. Other facilities would include a tailings pump station, an extension of the tailings pipeline, tailings distribution lines, access roads and a patrol road, a powerline, a seepage collection pond, surface water diversion channels, and a decant water channel. The project would provide additional storage for approximately 200 million tons of tailings from Molycorp's molybdenum mine located approximately 12 miles east of Guadalupe Mountain. The Bureau of Land Management (BLM) completed an Environmental Assessment (EA) for this project in February 1985. As a result of that EA, the BLM determined that an Environmental Impact Statement (EIS) would be required. The EIS analyzes and documents the environmental impacts of the proposed project through construction, operation, and closure.

33168 (PB–90-184557/XAB) **Pretreatment compliance monitoring and enforcement software. User's guide. version 2.0. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Water Enforcement and Permits. Sep 1989. 59p. (EPA–505/8-90/003). Available from NTIS, PC A04/MF A01.

The Pretreatment Compliance Monitoring and Enforcement System (PCME System) is designed to assist Publicly Owned Treatment Works and other Control Authorities in tracking an industrial user's compliance with applicable pretreatment standards. The menu-driven PCME System provides an automated means for doing this. The PCME System User Guide provides step-by-step procedures to assist anyone in operating the system (entering and updating information and generating reports). The PCME System does not require any special hardware other than an IBM or Compatible Personal Computer, a hard disk, and at least 384K of RAM. The PCME System also assumes that you are running a disk-operating system. The PCME System tracks Significant Noncompliers and generates a Pretreatment Pretreatment Performance Summary report as well.

33169 (PB–90-185059/XAB) **Modeling organic-contaminant sorption impacts on aquifer restoration.** Miller, C.T.; Pedit, J.A.; Staes, E.G.; Gilbertsen, R.H. North Carolina Water Resources Research Inst., Raleigh, NC (USA). Jul 1989. 106p. (UNC-WRRI–89-246). Available from NTIS, PC A06/MF A01.

The ground-water resources of the U.S. have been contaminated by a variety of organic pollutants that include solvents, petroleum products, and pesticides. A need exists to understand the movement of contaminants in the subsurface so that: (1) an assessment of the risk due to contamination may be made, (2) an economical and environmentally acceptable response to contamination may be designed, and (3) an appropriate ranking of sites that require cleanup and that are competing for the same fixed pool of resources may be accomplished. Many common organic contaminants sorb to solid surfaces, like soils or aquifer materials. This work focuses on the investigation of the sorption process in the subsurface.

33170 (PB–90-185133/XAB) **Interlaboratory methods comparison for the total organic carbon analysis of aquifer materials.** Powell, R.M.; Bledsoe, B.E.; Curtis, G.P.; Johnson, R.L. Environmental Protection Agency, Ada, OK (USA). Robert S. Kerr Environmental Research Lab. c 1989. 6p. (EPA–600/J-89/276). Available from NTIS, PC A02/MF A01.

Pub. in Environmental Science and Technology, Vol. 23, No. 10, 1246-1249(Oct 1989).

The total organic carbon (TOC) content of aquifer materials has been found to have significant effects on the movement of pollutants in the subsurface environment. Accurate quantification of TOC is therefore of great importance to research in ground-water contamination. However, large discrepancies have been observed when laboratories employing different methods determine TOC on the same aquifer material. The study was undertaken to evaluate the extent of these differences and examine their causes. Five subsurface samples were distributed and analyzed for both total carbon and total organic carbon by several instrumental techniques at four laboratories. Results indicate that when the material is adequately prepared with regard to homogeneity and removal of carbonate minerals, reasonably comparable values are obtained for all the instruments used, with the exception of a wet oxidation technique that is insufficiently oxidizing. Trends in subsurface research indicate a need for methods with improved accuracy and precision to lower detection limits and increase reliability.

33171 (PB–90-185927/XAB) **Development of an expert-system embedding pattern-recognition techniques for pollution-source identification. Report for 30 September 1987-29 November 1989.** Datta, B.; Beegle, J.E.; Kavvas, M.L.; Orlob, G.T. California Univ., Davis, CA (USA). Dept. of Civil Engineering. 1989. 165p. Available from NTIS, PC A08/MF A01.

A new methodology for the identification of unknown sources of ground-water pollution is developed. The new methodology is based on the concept of statistical pattern recognition. The statistical pattern-recognition algorithm uses Bayes' Optimal Decision Rule. The function of the pattern-recognition system is to match statistically an observed set of concentrations in the field with a comparable set obtained by simulating ground-water transport for various disposal conditions. In order to make the application of the methodology easier, an Expert System was developed. The Expert System uses the results obtained by applying the pattern-recognition algorithm to select a particular set of pollution-source locations and magnitudes. The Expert System also has the capability of adding measures of confidence to alternative selections of sources made by the pattern-recognition system, such that these solutions can be ranked according to the subjective confidences supplied by the users. The performance of the pattern-recognition system and the Expert System was evaluated for a selected study area.

33172 (PB–90-186172/XAB) **Strategies for assessing the cumulative effects of wetland alteration on water quality.** Brinson, M.M. East Carolina Univ., Greenville, NC (USA). c 1988. 10p. Available from NTIS, PC A02/MF A01.

Pub. in Environmental Management, Vol. 12, No. 5, 655-662(Sep 1988).

Assessment of cumulative impacts on wetlands can benefit by recognizing three fundamental wetland categories: basin, riverine, and fringe. The geomorphological settings of these categories have relevance for water quality. Biogeochemical influences tend to be local rather than having a measurable affect on the larger body of water. Consequently, the function of these wetlands for critical habitat may warrant a category for protection from high nutrient levels and toxins, rather than expecting them to assume an assimilatory role. The relative proportion of these wetland types within a watershed and their status relative to past impacts can be used to develop strategies for wetland protection. Past impacts on wetlands, however, are not likely to be clearly revealed in water-quality records from monitoring studies, either because records are too short or because too many variables other than wetland impacts affect water quality. It is suggested that hydrologic records be used to reconstruct historical hydroperiods in wetlands for comparison with current, altered conditions. Changes in hydroperiod imply changes in wetland function, especially for biogeochemical processes in sediments. Hydroperiod is potentially a more sensitive index of wetland function than surface areas obtained from aerial photographs. Finally, the depositional environment of wetlands is a landscape characteristic that has not been carefully evaluated nor fully appreciated. Impacts that reverse depositional tendencies also may accelerate rates of change, causing wetlands to be large net

exporters rather than modest net importers. Increases in rates as well as direction can cause stocks of materials accumulated over centuries in wetland sediments to be lost within decades, resulting in nutrient loading to downstream aquatic ecosystems.

33173 (PB–90-186180/XAB) **Cumulative impacts on water-quality functions of wetlands.** Hemond, H.F.; Benoit, J. Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Civil Engineering. c 1988. 18p. Available from NTIS, PC A03/MF A01.

Pub. in Environmental Management, Vol. 12, No. 5, 639-653(Sep 1988).

Cumulative impacts on the water-quality function of wetlands are impacts whose total effect cannot be predicted from the sum of the effects of individual impacts. The wetland is not a simple filter; it embodies chemical, physical, and biotic processes that can detain, transform, release, or produce a wide variety of substances. Because wetland water-quality functions result from the operation of many individual, distinct, and quite dissimilar mechanisms, it is necessary to consider the nature of each individual process. Given knowledge of the various wetland processes, it is possible to make more-guided judgments about the effects a suite of impacts is likely to have. When considered in this light, many common wetland alterations seem likely to involve cumulative impact. The wetland manager may be guided further by appropriate field measurements at specific sites; such data can aid in predicting cumulative impact or assessing the results of past wetland management.

33174 (PB–90-186206/XAB) **Evaluating cumulative effects of disturbance on the hydrologic function of bogs, fens, and mires.** Siegel, D.I. Syracuse Univ., NY (USA). c 1988. 8p. Available from NTIS, PC A02/MF A01.

Pub. in Environmental Management, Vol. 12, No. 5, 621-626(Sep 1988).

Few quantitative studies have been done on the hydrology of fens, bogs, and mires and, consequently, any predictions of the cumulative impacts of disturbances on their hydrologic functions is extremely difficult. Bogs and fens are, in a sense, hydrobiologic systems, and any evaluation of cumulative impacts on them will have to consider the complicated interactions, barely understood, among the wetland hydrology, water chemistry, and biota, and place the effect of individual wetland impacts within the context of the cumulative impacts contributed to the watershed from other geomorphic areas and land uses. It is difficult to evaluate the potential cumulative impacts on wetland hydrology because geologic settings of wetlands are often complex and the methods used to measure wetland stream flow, ground-water flow, and evapotranspiration are inexact. Their very scale makes it difficult to quantify the hydrologic function accurately. The paper reviews current understanding of the hydrologic function of bogs, fens, and mires at different scales and in different physiographic settings, and presents hypotheses on potential cumulative impacts on the hydrologic function that might occur with multiple disturbances.

33175 (PB–90-186222/XAB) **Cumulative impacts on wetlands: Linking scientific assessments and regulatory alternatives.** Lee, L.C.; Gosselink, J.G. Environmental Protection Agency, Corvallis, OR (USA). Environmental Research Lab. c 1988. 14p. (EPA–600/J-88/494). Available from NTIS, PC A03/MF A01.

Pub. in Environmental Management, Vol. 12, No. 5, 591-602(Sep 1988).

The article is an extension and application of Preston and Bedford (1988), especially as relevant to bottomland hardwood (BLH) forests of the southeastern United States. The most important cumulative effects in BLH forests result from incremental forest loss (nibbing) and from synergisms resulting from nibbing. Present regulatory procedures are ineffective in preventing incremental forest loss because of the focus on permit site evaluation, rather than on large landscapes. Three examples are given to illustrate the need for a landscape focus. The perspective requires preplanning or goal setting to establish the desired conditions to be maintained in the regulated-landscape unit. Reference data sets must be developed, relating BLH function to structure. The data sets can be used to set goals for individual watersheds, based on their present conditions and the magnitude and type of perceived development pressures. The crucial steps in establishing a successful program appear to be: establish study unit boundaries; assess the condition of study-unit-landscape integrity; set goals; and consider the impacts of permit proposals with both goals and the existing condition of the study-unit landscape in mind.

33176 (PB–90-186404/XAB) **Superfund Record of Decision (EPA Region 4): Ciba-Geigy (McIntosh Plant), AL. (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 28 Sep 1989. 37p. (EPA/ROD/R–04-89/056). Available from NTIS, PC A03/MF A01.

The 1,500-acre Ciba-Geigy (McIntosh Plant) site is in southern Washington County, northeast of McIntosh, Alabama. The plant's initial operations, which began in 1952, were devoted solely to the manufacture of DDT. In 1970, the facility expanded its manufacturing operations to include herbicides, insecticides, and chelating and sequestering agents. Other products produced by Ciba-Geigy include resins and additives used in the plastics industry. Wastes and residues generated during production operations were managed onsite. In 1985, EPA issued Ciba-Geigy a RCRA Part B permit for active waste-management units onsite. The permit included a corrective-action plan requiring Ciba-Geigy to remove and treat contaminated ground water and surface water at the site. In 1987, as part of this plan, Ciba-Geigy installed a ground-water pumping and treatment system which has been effective in addressing the ground-water contamination. The primary contaminants of concern affecting the ground-water are VOCs including benzene and toluene; other organics including pesticides; and metals including arsenic.

33177 (PB–90-186479/XAB) **Superfund Record of Decision (EPA Region 6): Sheridan Disposal Services Site, Waller County, Texas (Second remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 27 Sep 1989. 93p. (EPA/ROD/R–06-89/051). Available from NTIS, PC A05/MF A01.

Portions of this document are not fully legible.

The 110-acre Sheridan Disposal Services site is approximately 9 miles northwest of the city of Hempstead in Waller County, Texas. The site is located on the 100-year floodplain of the Brazos River and is bordered by a lake to the south, farmland, and a community of 20 residences to the north. The Evangeline aquifer, which runs under the site, is used to meet the drinking-water needs of several communities nearby. Sheridan Disposal Services operated as a commercial waste-disposal facility from about 1958 to 1984 using steam distillation, open burning, incineration, and direct disposal into a waste lagoon to dispose of various organic and inorganic chemical and solid wastes. The primary contaminants of concern affecting the soil and sludge are VOCs including benzene and toluene, and other organics including PCBs. The selected remedial action for the site includes excavation of all material with PCB concentrations greater than 25 mg/kg including 13,000 yd^3 of pond and dike soil, 31,000 yd^3 of pond sludge, and 300 yd^3 of floating oil and emulsion in the pond and storage tanks.

33178 (PB–90-186495/XAB) **Technology evaluation report: SITE program. CF Systems organics extraction system, New Bedford, Massachusetts. Volume 1. Final report.** Valentinetti, R. Science Applications International Corp., McLean, VA (USA). Jan 1990. 106p. Available from NTIS, PC A06/MF A01.

See also Volume 2, PB–90-186503.

This report summarizes the results of a Superfund Innovative Technology Evaluation (SITE) demonstration of the CF Systems critical fluid organics extraction system at the New Bedford Harbor, Massachusetts Superfund site. The technology depends on the ability of organic pollutants to solubilize in the process solvent, a liquefied gas. The pollutants treated include polychlorinated biphenyls (PCBs) and polynuclear aromatic hydrocarbons. The report examines the performance of the process in terms of PCB extraction efficiency, variation in process operating conditions, potential health and safety impacts, equipment and handling problems, and projected system economics. Volume I covers process design, field activities, sampling and analytical program, and results and discussion.

33179 (PB–90-186503/XAB) **Technology evaluation report: SITE program. CF Systems organics extraction system, New**

Bedford, Massachusetts. Volume 2. Final report. Valentinetti, R. Science Applications International Corp., McLean, VA (USA). Jan 1990. 173p. Available from NTIS, PC A08/MF A01.

See also Volume 1, PB–90-186495.

This report summarizes the results of a Superfund Innovative Technology Evaluation (SITE) demonstration of the CF Systems critical fluid organics extraction system at the New Bedford Harbor, Massachusetts Superfund site. The technology depends on the ability of organic pollutants to solubilize in the process solvent, a liquefied gas. The pollutants treated include polychlorinated biphenyls (PCBs) and polynuclear aromatic hydrocarbons. The report examines the performance of the process in terms of PCB extraction efficiency, variation in process operating conditions, potential health and safety impacts, equipment and handling problems, and projected system economics. Volume II contains sampling and analytical reports and operating-log data.

33180 (PB–90-186768/XAB) **Evaluation of detention-basin performance in the Piedmont region of North Carolina.** Wu, J.S. North Carolina Water Resources Research Inst., Raleigh, NC (USA). Jul 1989. 58p. (UNC-WRRI–89-248). Available from NTIS, PC A04/MF A01.

Results are summarized of a stormwater sampling program conducted on three existing urban wet detention ponds in the Piedmont region of North Carolina in the city of Charlotte. These ponds were not originally designed for water-quality control. A total of eleven storm events was monitored. Runoff samples were analyzed for total suspended solids, total and ortho phosphorus, total Kjeldahl and ammonia nitrogen, and metals of iron, zinc, copper, and lead. The removal efficiency of pollutants for each detention pond was computed as the percent difference of the total pollutant mass entering and leaving the detention pond. A U.S. EPA model was employed to derive a relationship for estimating the size of detention ponds to achieve targeted levels of water-quality improvement.

33181 (PB–90-191529/XAB) **Analysis of mutagenic activity of biohazardous organics in Kanawha River sediments. Technical completion report.** White, A.R.; Waldron, M.C. West Virginia Univ., Morgantown, WV (USA). Water Research Inst. 1988. 20p. Available from NTIS, PC A03/MF A01.

Residual chemical contamination of Kanawha River sediments may constitute a health hazard. Sediment cores have been analyzed using a coupled bioassay/chemical fractionation procedure. Both bacterial mutagenicity and sister chromatid exchange (SCE) analyses were conducted on sediment samples. Pocatalico River sediments extracts showed no response in either bacterial mutagenicity assay or SCE assay. Extracts from Armour Creek and the Kanawha River induced mutagenicities in the presence of S9 enzymes. The same extracts produced a significant increase in human chromosomal cross-over events.

33182 (PB–90-862244/XAB) **Wetland areas: Natural water treatment systems. January 1978-August 1989 (a Bibliography from Pollution Abstracts). Report for January 1978-August 1989.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 114p. Available from NTISPC N01/MF N01.

Supersedes PB–89-863500.

This bibliography contains citations concerning the ability of salt marshes, tidal flats, marshlands, bogs, and other wetland areas to degrade, absorb, filter, consume, or mitigate natural and man-made pollution and wastes, while maintaining their ability to provide refuge and breeding grounds for wildlife. The ecology, biochemistry, and viability of naturally occurring and artificially established wetlands as water-treatment systems and wildlife areas are considered. The effects of individual pollutants, environmental factors, species diversity, and cleansing ability of wetland areas on the potential for wildlife refuge, sewage treatment, treatment of industrial and municipal wastes, handling agricultural runoff, mitigating accidental spills, and flooding are discussed. (This updated bibliography contains 243 citations, 21 of which are new entries to the previous edition.)

33183 (PB–90-862798/XAB) **Toxicity bioassays: Water pollution effects on aquatic animals and plants. June 1986-February 1990 (A bibliography from the Selected Water Resources Abstracts data base). Report for June 1986-February 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 97p. Available from NTISPC N01/MF N01.

Supersedes PB–89-864102.

This bibliography contains citations concerning toxicity-bioassay studies of water-pollution effects on reproduction, growth, and mortality of aquatic animals and plants. Industrial and agricultural water pollutants such as metals, chemicals, pesticides, and herbicides are evaluated and tested. Standard fishes and algal assays are used to determine effects of potential toxicants. (This updated bibliography contains 145 citations, 51 of which are new entries to the previous edition.)

33184 (PB–90-862889/XAB) **Organic solvent recovery and reclamation. June 1970-December 1989 (A Bibliography from the COMPENDEX data base). Report for June 1970-December 1989.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 77p. Available from NTISPC N01/MF N01.

Supersedes PB–88-863238.

This bibliography contains citations concerning extraction, recovery, and reclamation of solvents and components of solvents which are used in various mineral, manufacturing, processing, and reprocessing industries. Design, operation, performance, and maintenance of equipment used for this purpose are included. (This updated bibliography contains 170 citations, 22 of which are new entries to the previous edition.)

33185 (PB–90-862947/XAB) **Activated charcoal. October 1976-December 1989 (A Bibliography from the COMPENDEX data base). Report for October 1976-December 1989.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 88p. Available from NTISPC N01/MF N01.

Supersedes PB–89-873871.

This bibliography contains citations concerning theoretical aspects and industrial applications of activated charcoal. Topics include absorption capacity and mechanism studies, kinetic and thermodynamic aspects, and properties descriptions and evaluations. Applications include use in water analyses and waste treatment, air pollution control and measurement, and in nuclear facilities. (This updated bibliography contains 176 citations, 16 of which are new entries to the previous edition.)

33186 (PB–90-864141/XAB) **Sediment-water interactions and their effects upon water quality. January 1979-March 1990 (A Bibliography from the NTIS data base). Report for January 1979-March 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 107p. Available from NTISPC N01/MF N01.

Supersedes PB–89-857122.

This bibliography contains citations concerning contaminant transport and fate in hydraulic systems containing sediments. Topics include nutrient recycling, absorption and desorption of a variety of contaminants, ion-exchange processes, and the use of transport models in contamination studies. Citations pertaining specifically to marine environments are excluded. (This updated bibliography contains 167 citations, 27 of which are new entries to the previous edition.)

33187 (PB–90-864166/XAB) **Polychlorinated biphenyls: Occurrence in sediments and soils. January 1977-March 1990 (A Bibliography from the Selected Water Resources Abstracts data base). Report for January 1977-March 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 179p. Available from NTISPC N01/MF N01.

Supersedes PB–89-855993.

This bibliography contains citations concerning field and laboratory analyses of polychlorinated biphenyls in sediments and soils. Topics include site studies, chemical analyses of adsorption-desorption processes, decomposition in soils, including biodegradation, and bioaccumulation. Detection methods and equipment, and the impact of dredging in contaminated areas are also discussed. (This updated bibliography contains 299 citations, 50 of which are new entries to the previous edition.)

33188 (PNL–7335) **Concentrations of metals in Norton Sound seawater samples and human hair samples, 1989.** Crecelius, E.A. (Battelle/Marine Sciences Lab., Sequim, WA (USA)); Apts, C.W.; Lasorsa, B.K. Minerals Management Service, Anchorage, AK (USA). Alaska Outer Continental Shelf Region; Battelle/Marine Sciences Lab., Sequim, WA (USA). Apr 1990. 37p. Sponsored by U.S. Department of the Interior. DOE Contract AC06-76RL01830. (OCS/MMS–90-0010). Order Number DE90010857. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A limited survey conducted in the summer of 1989 indicted that concentrations of seven metals(As, Cd, Hg, Ni, Pb, Zn) in Norton Sound seawater are typical of coastal seawater. Of particular interest was Hg, which was determined to be in the range of 1 to 2 ng/L. Pacific Northwest Laboratory staff sampled seawater near Nome in June and September 1989. These seawater samples and sediment samples were analyzed for trace metals with the following objectives: to determine the concentrations of metals in surface and bottom water within 30 miles of Nome, to determine the concentrations of metals up-current and down-current of the BIMA gold dredge while the dredge was operating, to compare the U.S. Environmental Protection Agency (EPA) total recoverable digestion technique for the analysis of metals in seawater with other analytical-chemical methods, and to determine the concentrations of metals in sediment elutriates. In a related issue, few data were available on the levels of mercury and arsenic in Nome residents through 1988. To fill this data need, samples of hair collected from Nome women of child-bearing age were analyzed to determine the concentrations of mercury and arsenic. 13 refs., 1 fig. 12 tabs.

33189 **Coupled biological downflow fluid bed reactor treatment of synfuels wastewater.** Turner, C.D. (Energy and Mineral Research Center, Univ. of North Dakota, Grand Forks, ND (US)); Ong, C.S.; Gallagher, J.R. 469-477 of Proceedings of the 43rd industrial waste conference. Lewis Publishers, Chelsea, MI (USA) (1989). (CONF-8805322–: 43. industrial waste conference, West Lafayette, IN (USA), 10-12 May 1988).

This research involved the application of coupled fluid bed reactors that combine nitrification and denitrification with organics removal in hydraulically connected anoxic and toxic columns for the treatment of synfuels wastewater from the Great Plains Gasification Plant (GPGP) near Beulah, North Dakota. The wastewater contained BOD_5 and ammonia concentrations of 1250 mg/L and 1100 mg/L, respectively. The wastewater was treated at the University of North Dakota Energy and Mineral Research Center where the coupled bed process reduced the BOD_5 and ammonia concentrations by 80% or more each. This paper reviews the fundamentals of the treatment process, previous research, bench-scale equipment, operation and results of the research.

33190 **Examination of the impact of radioactive liquid effluent releases from the Rancho Seco Nuclear Power Plant.** Miller, C.W. (Oak Ridge National Laboratory, TN (USA)); Cottrell, W.D.; Loar, J.M.; Witherspoon, J.P. *Health Physics (USA)*, 58(3): 263-274 (Mar 1990).

A project has been carried out by Oak Ridge National Laboratory (ORNL) to estimate the concentrations of radionuclides in the environment resulting from the release of radioactive materials in the liquid waste effluents from the Rancho Seco Nuclear Power Plant (RSNPP) and to estimate possible radiation doses to man resulting from current environmental concentrations. To accomplish the objectives of this project, ORNL staff members conducted an environmental sampling program around the plant site during November and December 1984. Elevated levels of some anthropogenic radionuclides were found in the immediate environment of the plant. This radioactive contamination occurs primarily along streams receiving effluent from the plant and in fields irrigated with water from these streams. The primary contaminants are ^{137}Cs and ^{134}Cs, with lesser amounts of ^{60}Co and ^{58}Co. The ingestion of fish was the single most important pathway identified in this analysis. However, all specific pathways of exposure and usage factors were not precisely known for a complete dose assessment of current and potential use of contaminated water and soil around the RSNPP. The liquid effluent radionuclide releases from the RSNPP pose no significant health hazard to persons living near the RSNPP.

33191 **Method and apparatus for the in situ decontamination of underground water with the aid of solar energy.** Bench, T.R.; McCann, L.D. To Dept. of Energy, Washington, DC. USA Patent 4882071/A/. 21 Nov 1989. Filed date 21 Jan 1988. USA Patent Application 7-146,638. Int. Cl. F24J 3/02. 10p.

This patent describes a method for the in situ decontamination of underground water containing non-volatile contaminants. It comprises: continuously contacting in situ underground water containing non-volatile contaminants with a liquid-absorbent material possessing high capillary activity, allowing the non-volatile contaminants to deposit in the material while the water moves upwardly through the material by capillary action, allowing substantially decontaminated water to be volatilized by impinging solar radiation, and then allowing the volatilized water to escape from the material into the atmosphere. Also described is an apparatus for the in situ decontamination of underground water containing non-volatile contaminants. It comprises: at least one water-impermeable elongated conduit having an upper portion and first and second open ends and containing a homogeneous liquid-absorbent material possessing high capillary activity, means for supporting the conduit, and means for accelerating the escape of the volatilized decontamined water from the material.

55 BIOMEDICAL SCIENCES, BASIC STUDIES

Refer also to citation(s) 33631

5501 Behavioral Biology

Refer also to citation(s) 33196

5502 Biochemistry

Refer also to citation(s) 32227, 32793, 33211, 33215, 33259, 33260

33192 (CONF-900512–1) **Preparative purification of Trichoderma reesei native and "core" Cellobiohydrolase I by electrophoresis and chromatofocussing.** Offord, D.A.; Lee, N.E.; Woodward, J. Oak Ridge National Lab., TN (USA). [1990]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 12. symposium on biotechnology for fuels and chemicals; Gatlinburg, TN (USA); 7-11 May 1990. Order Number DE90010706. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The enzymes present in the cellulase complex produced by the fungus Trichoderma reesei have been the subject of considerable attention due to their potential for converting cellulosic materials into glucose for further use in fermentation processes. Cellobiohydrolase I (CBH I) is the major component of crude commercial fungal cellulase preparations and catalyzes the conversion of insoluble cellulose into cellobiose. We have been interested, recently, in the reduction of native and "core" CBH I (the primary structure of CBH I with a catalytic head region) and have needed to develop a method for their preparative purification. We now report that by using electrophoresis and chromatofocussing, preparative quantities of both native and "core" CBH I have been obtained. Since their pI values are different, milligram quantities of "core" CBH I can be generated and purified from the native enzyme by chromatofocussing within 2 hours. 13 refs., 7 figs., 2 tabs.

33193 (DOE/ER/13255–6) **[Hydroxyproline-rich glycoproteins of the plant cell wall]: Progress report, June 1989–June 1990.** Varner, J.E. Washington Univ., St. Louis, MO (USA). [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER13255. Order Number DE90010960. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We are studying the chemistry and architecture of plant cells walls, the extracellular matrices that taken together shape the plant and provide mechanical support for the plant. Cell walls are dynamic structures that regulate, or are the site of, many physiological processes, in addition to being the cells' first line of defense against invading pathogens. In the past year we have examined

the role of the cell wall enzyme ascorbic acid oxidase as related to the structure of the wall and its possible interactions with hydroxyproline-rich glycoproteins of the wall.

33194 (DOE/ER/13729–2) **Role of acyl carrier protein isoforms in plant lipid metabolism: Progress report.** Michigan State Univ., East Lansing, MI (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER13729. Order Number DE90010959. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Although acyl carrier protein (ACP) is the best studied protein in plant fatty acid biosynthesis, the in vivo forms of ACPs and their steady state pools have not been examined previously in either seed or leaf. Information about the relative pool sizes of free ACP and its acyl-ACP intermediates is essential for understanding regulation of de novo fatty acid biosynthesis in plants. In this study we utilized antibodies directed against spinach ACP as a sensitive assay to analyze the acyl groups while they were still covalently attached to ACPs. 4 refs., 4 figs.

33195 (DOE/ER/14004–1) **[Molecular characteristics of the lignin forming peroxidase]: Progress report.** Lagrimini, L.M. Ohio State Univ. Research Foundation, Columbus, OH (USA). 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER14004. Order Number DE90010880. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Since this manuscript was submitted we have conducted a more thorough physiological analysis of water relations in wild-type and peroxidase overproducing plants. These experiments include pressure bomb, plasmolysis, and membrane integrity analysis. We are also in the process of analyzing other phenotypes in peroxidase overproducer plants such as excessive browning of tissue, the rapid death of tissue in culture, and poor germination of seed. Transformed plants of Nicotiana tabacum and Nicotiana sylvestris were obtained which have peroxidase activity 3–7 fold lower than wild-type plants. This was done by introducing a chimeric gene composed of the CaMV 35S promoter and the 5' half of the tobacco anionic peroxidase cDNA in the antisense RNA configuration. A manuscript which describes this work is being written, and will be submitted for publication in January 1990. The anionic peroxidase gene has been cloned by hybridization to the cloned cDNA. The entire gene is contained on an 8.7kb fragment within a lambda phage clone. Several smaller DNA fragments have been subcloned, and some have been sequenced. One exon within the coding sequence has been sequenced, along with the partial sequence of two introns. Further sequencing is being carried-out to identify the promoter, which will be later joined to a reporter gene. 6 figs.

33196 (UCRL–102985) **Application of AMS [accelerator mass spectrometry] to the biomedical sciences.** Vogel, J.S.; Gledhill, B.L.; Proctor, I.D.; Turteltaub, K.W.; Nelson, D.E.; Davis, J.C.; Felton, J.S.; Southon, J.R. Lawrence Livermore National Lab., CA (USA). 18 Apr 1990. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900491–5: 5. international conference on accelerator mass spectrometry, Paris (France), 23-27 Apr 1990). Order Number DE90010869. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Radioisotopic tracers are a useful tool in numerous areas of biomedical research, including metabolism, pharmacokinetics, and the detailed study of biomolecular interactions. Accelerator mass spectrometry was suggested as a tool for the biomedical sciences shortly after its invention, but few attempts to use its sensitivity in such research have been reported. We have examined some of the strengths and limitations of the technique and find that AMS has a sensitivity advantage over decay-counting for the long-lived radioisotopes and for shorter-lived, common radiotracers. The advantage can be translated into the use of much smaller sample sizes and much lower radioisotope concentrations, both of which present new opportunities for biochemical tracing and human research. New approaches to separation and preparation of the material to be assayed for radiotracers will be developed to take advantage of the sensitivity and specificity. Most biochemical laboratories have used radioactive isotopes as tracers and their facilities have been contaminated with unacceptably high levels of these tracers. Careful protocols and/or new facilities are required to prevent contamination of the AMS samples. 23 refs., 3 figs.

33197 Fluorescence line narrowing spectrometry: A versatile tool for the study of chemically initiated carcinogenesis. JANkowiak, R. (Ames Lab., IA (USA)); Pei-qi, L.; Small, G.J. 1-1 of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 374.

For many carcinogenic compounds such as the polycyclic aromatic hydrocarbons (PAH), metabolic activation to electrophilic intermediates is a necessary condition for the production of damage of nucleic acids, e.g., DNA, arising from covalent binding with the metabolite. The current view for PAH is that metabolic activation occurs by two pathways: monooxygenation to yield bay-region diol-epoxides and one-electron oxidation to produce radical cations. A firm understanding of these events requires a versatile and rapid bioanalytical technique which is both highly sensitive and elective. FLN spectrometry, a method by which highly characteristic spectra can be obtained, has been shown to possess the required attributes for the analysis of cellular macromolecular (e.g., DNA, globin) damage resulting from covalent binding between the macromolecule and carcinogenic metabolites of PAH. Thus far, however, FLN spectrometry has only been applied to PAH metabolites and macromolecular DNA adducts obtained invitro. In this paper we demonstrate that with the present level of detectability, FLN is applicable to analysis of DNA damage on samples from animals and humans. The results from an FLN analysis of DNA from mouse skin, fish liver and from human placenta are presented and discussed.

33198 Capillary electrophoresis combined with mass spectrometry. Smith, R.D. (Pacific Northwest Lab., Richland, WA (USA)); Udseth, H.R.; Loo, J.A.; Barinaga, C.J. 1-1 of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). DOE Contract AC06-76RL01830. (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Astr. 1008.

Capillary electrophoresis (CE) is attracting extensive attention as a fast, high resolution analytical and micro-preparative separation technique. Broadly define, CE encompasses zone electrophoresis (CZE), micellar electrokinetic chromatography, isoelectric focusing, and isotachophoresis (CITP). The common features of these techniques are the use of small diameter capillaries (10 to 200 μm) and high voltages (5 to 60 kV). Separations obtaining more than 10^6 theoretical plates in less than twenty minutes have been demonstrated. Recently the authors described the on-line combination of CE with mass spectrometry (CE-MS) based upon electrospray ionization (ESI) source that allows ion production at atmospheric pressure from the terminus of the capillary. The high charged droplets result in a field assisted ion desorption process that allows labile and nonvolatile analytes to be addressed. The multiple charging ESI phenomenon allows high molecular weight biological materials (e.g., proteins) to be analyzed with conventional mass spectrometers. the ion desorption process is dependent upon the liquid composition and can be made high selective. The ability to inject, separate with high efficiency, and detect biologically important compounds (with attomole to femtomole range detection limits) by CE-MS can be the basis for dramatic advances in numerous research areas where samples are obtained in small quantities or at great expense. Recent developments in CE-MS interfacing are presented, and results obtained for a wide range of samples are described. A new interface design allowing both CE and electrospray ionization under a wide range of conditions is described. The extension of these methods to capillary isotachophoresis and capillary gel electrophoresis is demonstrated.

33199 Characterization of alkylated nucleosides by laser ionization Fourier transform mass spectrometry. Hettich, R.L. (Oak Ridge National Lab., TN (USA). Analytical Chemistry Div.). 1-1 of Pittsburgh conference 1989 and exposition on analytical

chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-890331--: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 479.

In addition to alkylated nucleosides, small intact oligonucleotides can also be examined for modifications. For example, laser ionization of an alkylated oligomer hexamer containing the four normal nucleic bases of DNA along with one methylated adenine, d(N^6meA-T-G-C-A-T), generated negative ions which could be used to identify the specific nucleic bases. Fragmentation of this oligomer precluded determination of the nucleic base sequence; however, the identities and modifications of each nucleic base in the oligomer could be determined. Collisional dissociation of the ion corresponding to the methylated adenine provided the information necessary to determine the position of methyl substitution (which was N^6 in this case). The structural characterization of DNA adducts at the isomeric level is required for understanding the nature of DNA modification by carcinogenic and mutagenic agents. Laser ionization Fourier transform mass spectrometry (FTMS) is well-suited for the examination of modified nucleic acid constituents since this technique can be used to obtain structural information on a small amount of sample (picomoles). Laser desorption provides a relatively soft ionization method for these non-volatile, thermally labile compounds. Once the ions have been generated by laser ionization, they can be investigated with the various experimental sequences available with FTMS. This paper describes an experiment in which several methylated isomers of adenosine, guanosine, cytidine, and thymidine were examined by this technique.

33200 Neutron diffraction of alpha, beta and gamma cyclodextrins: Hydrogen bonding patterns. Hingerty, B. (Oak Ridge National Lab., TN (USA)); Klar, B.; Hardgrove, G.L.; Betzel, C.; Saenger, W. *Journal of Biomolecular Structure and Dynamics (USA),* 2(1): 249-260 (Aug 1984).

Cyclodextrins (CD's) have proved useful as model systems for the study of hydrogen bonding. They are torus-shaped molecules composed of six(alpha), seven(beta) or eight(gamma) (1—4) linked glucoses. Because of their particular geometry, they are able to act as a host to form inclusion complexes with guest molecules very much like enzymes. Cyclodextrins have been shown to exert catalytic activity on suitable included-substrate molecules; they catalyze the hydrolysis of phenylacetates, of organic pyrophosphates and of penicillin derivatives. They also accelerate aromatic chlorinations and diazo coupling by means of their primary and/or secondary hydroxyl groups, so that the rates of hydrolysis are enhanced by up to a factor of 400. In order to understand the hydrogen bonding in these enzyme models, neutron diffraction data were collected to unambiguously determine the hydrogen atom positions, which could not be done from the x-ray diffraction data. alpha-CD has been shown to have two different structures with well-defined hydrogen bonds, one tense and the other relaxed. An induced-fit-like mechanism for alpha-CD complex formation has been proposed. Circular hydrogen bond networks have also been found for alpha-CD due to the energetically favored cooperative effect. beta-CD with a disordered water structure possesses an unusual flip-flop hydrogen bonding system of the type O-H...H-O representing an equilibrium between two states: O-H...O in equilibrium O...H-O. gamma-CD with a disordered water structure similar to beta-CD also possesses the flip-flop hydrogen bond. This study demonstrates that hydrogen bonds are operative in disordered systems and display dynamics even in the solid state. 33 references.

33201 Localization versus delocalization of the Davydov soliton: Dispersive collapse under the Schroedinger equation. Rhodes, W. (Department of Chemistry, The Florida State University, Tallahassee, FL (USA)— Institute of Molecular Biophysics, The Florida State University, Tallahassee, Florida 32306 (USA)); Nicholls, A. *Physical Review Letters (USA),* 64(10): 1174-1177 (5 Mar 1990). DOE Contract FG05-86ER60473.

The exact Schroedinger equation involving a modified Froehlich Hamiltonian used in Davydov soliton theory is formulated in terms of unitary time displacement and phonon coordinate displacement operators. Use is made of the sparse nature of the resulting matrix operators to develop an algorithm for vector processing on the Cyber 205 supercomputer. All numerical calculations lead us to conclude that the Schroedinger equation does not support the existence of the Davydov soliton as a persistent localized entity.

33202 Theoretical analysis of resonance Raman spectra from the blue copper protein azurin. Belhadj, M. (Univ. of Texas, Austin (USA)); Jean, J.M.; Friesner, R.A.; Schoonover, J.; Woodruff, W.H. *Journal of Physical Chemistry (USA),* 94(5): 2160-2166 (8 Mar 1990).

Using a time domain methodology, we have simulated low-temperature resonance Raman data from the blue copper protein azurin in an effort to determine an effective harmonic potential surface (relative to the ground-state geometry and normal coordinates) for the 600-nm transition of the blue copper active site. We find that utilization of overtone and combination intensities greatly facilitates the extraction of reliable parameter values. We are able in this manner to obtain accurate results for the linear displacements of the excited-state surface.

33203 DpnA, a methylase for single-strand DNA in the Dpn II restriction system, and its biological function. Cerritelli, S. (Brookhaven National Lab., Upton, NY (USA)); Springhorn, S.S.; Lacks, S.A. *Proceedings of the National Academy of Sciences of the United States of America (USA),* 86(23): 9223-9227 (Dec 1989).

The two DNA-adenine methylases encoded by the Dpn II restriction gene cassette were purified, and their activities were compared on various DNA substrates. DpnA was able to methylate single-strand DNA and double-strand DNA, whereas DpnM methylated only double-strand DNA. Although both enzymes act at 5′-GATC-3′ in DNA, DpnA can also methylate sequences altered in the guanine position, but at a lower rate. A deletion mutation in the dpnA gene was constructed and transferred to the chromosome. Transmission by way of the transformation pathway of methylated and unmethylated plasmids to dpnA mutant and wild-type recipients was examined. The mutant cells restricted unmethylated donor plasmic establishment much more strongly than did wild-type cells. In the wild type, the single strands of donor plasmid DNA that enter by the transformation pathway are apparently methylated by DpnA prior to conversion of the plasmid to a double-strand form, in which the plasmid would be susceptible to the Dpn II endonuclease. The biological function of DpnA may, therefore, be the enhancement of plasmid transfer to Dpn II-containing strains of Streptococcus pneumoniae.

33204 Fidelity of DNA polymerases in DNA amplification. Keohavong, P. (Massachusetts Institute of Technology, Cambridge (USA)); Thilly, W.G. *Proceedings of the National Academy of Sciences of the United States of America (USA),* 86(23): 9253-9257 (Dec 1989). DOE Contract FG02-86ER60448.

Denaturing gradient gel electrophoresis (DGGE) was used to separate and isolate the products of DNA amplification by polymerase chain reaction (PCR). The strategy permitted direct enumeration and identification of point mutations created by T4, modified T7, Klenow fragment of polymerase I, and Thermus aquaticus (Taq) DNA polymerases. Incorrectly synthesized sequences were separated from the wild type by DGGE as mutant/wild-type heteroduplexes and the heteroduplex fraction was used to calculate the average error rate (mutations per base duplication). The error rate induced in the 104-base-pair low-temperature melting domain of exon 3 of the human hypoxanthine/guanine phosphoribosyltransferase (HPRT) gene was $\approx 3.4 \times 10^{-5}$ for modified T7, 1.3×10^{-4} for Klenow fragment, and 2.1×10^{-4} for Taq polymerases after a 10^6-fold amplification. The error rate for T4 DNA polymerase was not more than 3×10^{-6} error per base duplication. The predominant mutations were sequenced and found to be transitions of G·C to A·T for T4 and modified T7 DNA polymerases, and A·T to G·C for Taq polymerase. Klenow fragment induced both possible transitions and deletions of 2 and 4 base pairs.

33205 Ordered synthesis and mobilization of glycogen in the perfused heart. Brainard, J.R. (Los Alamos National Lab., NM (USA)); Hutson, J.Y.; Hoekenga, D.E.; Lenhoff, R. *Biochemistry (USA),* 28(25): 9766-9772 (12 Dec 1989).

The molecular order of synthesis and mobilization of glycogen in the perfused heart was studied by ^{13}C NMR. By varying the glucose isotopomer ([1-^{13}C]glucose or [2-^{13}C]glucose) supplied to the heart, glycogen synthesized at different times during the perfusion was labeled at different carbon sites. Subsequently, the in situ mobilization of glycogen during ischemia was observed by detection of labeled lactate derived from glycolysis of the glucosyl monomers. When [1-^{13}C]glucose was given initially in the perfusion and [2-^{13}C]glucose was given second, [2-^{13}C]lactate was detected first during ischemia and [3-^{13}C]lactate second. This result, and the equivalent result when the glucose labels were given in the reverse order, demonstrates that glycogen synthesis and mobilization are ordered in the heart, where glycogen is found morphologically only as β particles. Previous studies of glycogen synthesis and mobilization in liver and adipocytes have suggested that the organization of β particles into α particles was partially responsible for ordered synthesis and mobilization. The observations reported here for cardiac glycogen suggest that another mechanism is responsible. In addition to examine the ordered synthesis and mobilization of cardiac glycogen, the authors have selectively monitored the NMR properties of ^{13}C-labeled glycogen synthesized early in the perfusion during further glycogen synthesis from a second, differently labeled substrate. During synthesis from the second labeled glucose monomer, the glycogen resonance from the first label decreased in integrated intensity and increased in line width. These results suggest either that there is significant isotopic exchange of glucosyl monomers in glycogen during net synthesis or that glucosyl residues incorporated into glycogen undergo motional restrictions as further glycogen synthesis occurs.

33206 Dependence of the phototropic response of Arabidopsis thaliana on fluence rate and wavelength. Konjevic, R. (Michigan State Univ., East Lansing (USA)); Steinitz, B.; Poff, K.L. *Proceedings of the National Academy of Sciences of the United States of America (USA),* 86(24): 9876-9880 (Dec 1989).

In the phototropic response of Arabidopsis thaliana seedlings, the shape of the fluence-response relation depends on fluence rate and wavelength. At low fluence rates, the response to 450-nm light is characterized by a single maximum at about 0.3 $\mu mol \cdot m^{-2}$. At higher fluence rates, the response shows two distinct maxima, I and II, at 0.3 and 3.5 $\mu mol \cdot m^{-2}$, respectively. The response to 500-nm light shows a single maximum at 2 $\mu mol \cdot m^{-2}$, and the response to 510-nm light shows a single maximum at 4.5 $\mu mol \cdot m^{-2}$, independent of fluence rate. The response to 490-nm light shows a maximal at 4.5 $\mu mol \cdot m^{-2}$ and a shouider at about 0.6 $\mu mol \cdot m^{-2}$. Preirradiation with high-fluence 510-nm light from above, immediately followed by unilateral 450-nm light, eliminates maximum II but not maximum I. Preirradiation with high-fluence 450-nm light from above eliminates the response to subsequent unilateral irradiation with either 450-nm or 510-nm light. The recovery of the response following high-fluence 450-nm light is considerably slower than the recovery following high-fluence 510-nm light. Unilateral irradiation with low-fluence 510-nm light followed by 450-nm light results in curvature that is approximately the sum of those produced by either irradiation alone. Based on these results, it is proposed that phototropism in A. thaliana seedlings is mediated by at least two blue-light photoreceptor pigments.

33207 v-src induces clonal sarcomas and rapid metastasis following transduction with a replication-defective retrovirus. Stoker, A.W. (Univ. of California, Berkeley (USA)); Sieweke, M.H. *Proceedings of the National Academy of Sciences of the United States of America (USA),* 86(24): 10123-10127 (Dec 1989). DOE Contract AC03-76SF00098.

v-src is an effective carcinogen when expressed from Rous sarcoma virus (RSV) in vivo. Whereas RSV tumors require sustained oncogene expression, their growth is largely a balance between viral recruitment of tissues and host immune destruction of infected cells. The authors have therefore examined the tumorigenic potential of v-src in the absence of viral recruitment and viral antigen expression. v-src was introduced with high efficiency into chicken wing web tissues using replication-defective (rd) retroviral vectors. Clonal sarcomas were induced rapidly, and furthermore, v-src potentiated metastatic progression in ≈ 0.1%-1% of tumor clones with unexpectedly short latency. rd vectors proved effective not only in transducing v-src into tissues but also as insertional markers of tumor clonality. The rd vector present in most primary and metastatic tumors was a highly truncated form of RSV derived by viral transmission of spliced v-src mRNA; this vector should thus avoid viral recruitment and host anti-viral immune reaction through its complete lack of viral structural genes. Under such conditions v-src maintains strong carcinogenicity in vivo when restricted to clonal tumor growth and can confer rapid metastatic potential on a discrete subset of tumor clones.

5503 Cytology

Refer also to citation(s) 33196

5504 Genetics

Refer also to citation(s) 32055, 32056, 32077

33208 Single-sperm typing: Determination of genetic distance between the $^{G}\gamma$-globulin and parathyroid hormone loci by using the polymerase chain reaction and allele-specific oligomers. Cui, Xiangfeng (Univ. of Southern California, Los Angeles (USA)); Li, Honghua; Galas, D.; Arnheim, N.; Goradia, T.M.; Lange, K.; Kazazian, H.H. Jr. *Proceedings of the National Academy of Sciences of the United States of America (USA),* 86(23): 9389-9393 (Dec 1989). DOE Contract FG03-87ER60548.

The frequency of recombination between the $^{G}\gamma$-globin (HBG2) and parathyroid hormone (PTH) loci on the short arm of human chromosome 11 was estimated by typing >700 single-sperm samples from two males. The sperm-typing technique employed involves the polymerase chain reaction and allele-specific oligonucleotide hybridization. The maximum likelihood recombination fraction estimate of 0.16 falls well within previous estimates based on family studies. With current technology and a sample size of 1000 sperm, recombination fractions down to ≈0.009 can be estimated with statistical reliability; with a sample size of 5000 sperm, this value drops to about 0.004. Reasonable technological improvements could result in the detection of recombination frequencies <0.001.

33209 Description and validation of a method for simultaneous estimation of effective population size and mutation rate from human population data. Chakraborty, R. (Univ. of Texas Graduate School of Biomedical Sciences, Houston (USA)); Neel, J.V. *Proceedings of the National Academy of Sciences of the United States of America (USA),* 86(23): 9407-9411 (Dec 1989).

A method is presented for utilizing population data on electrophoretic variants of proteins to estimate simultaneously the effective sizes (N_e values) of the populations in question and the rate of mutation resulting in electromorphs at the loci whose products were surveyed. The method is applied to data from 12 relatively unacculturated Amerindian tribes for whom census data and independent estimates of the number of different electrophoretic variants at 27 loci are available. Because of the tribal demographic structure, N_e should be less than the current number of reproductive-aged adults. In fact, it is substantially greater for 7 tribes, most likely due to intertribal migration and a recent decrease in tribal size. Estimates of locus mutation rates for the 27 loci vary by more than a factor of 20, with an average of 1.1×10^{-5} per locus per generation. This latter estimate is in satisfactory agreement with the results of other indirect approaches to the estimation of mutation rates in these tribes but about two times higher than the results of direct estimates based on these same loci in studies on civilized populations. This discrepancy could be due to the above-hypothesized migration and to decreases in tribal size.

33210 The Huntington disease locus is most likely within 325 kilobases of the chromosome 4p telomere. Doggett, N.A. (Columbia Univ., New York, NY (USA)); Cheng, J.F.; Smith, C.L.; Cantor, C.R. *Proceedings of the National Academy of Sciences of the United States of America (USA),* 86(24): 10011-10014 (Dec 1989).

The genetic defect responsible for Huntington disease was originally localized near the tip of the short arm of chromosome 4 by genetic linkage to the locus D4S10. Several markers closer to

Huntington disease have since been isolated, but these all appear to be proximal to the defect. A physical map that extends from the most distal of these loci, D4S90, to the telomere of chromosome 4 was constructed. This map identifies at least two CpG islands as markers for Huntington disease candidate genes and places the most likely location of the Huntington disease defect remarkably close (within 325 kilobases) to the telomere.

5505 Metabolism

Refer also to citation(s) 33196

33211 (DOE/ER/14011–1) **Hydrogen/sulfur metabolism in the hyperthermophilic archaebacterium Pyrodictium brockii: Progress report, March 1, 1989–February 28, 1990.** Maier, R.J. Johns Hopkins Univ., Baltimore, MD (USA). Dept. of Biology. 1 Mar 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER14011. Order Number DE90010901. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The mechanisms by which hyperthermophilic archaebacteria grow and carry out metabolic functions at elevated temperatures have yet to be determined. Progress along these lines requires some understanding of the roles that molecular hydrogen and elemental sulfur play in their metabolism. The objectives of the work proposed here include developing an understanding of the metabolic characteristics of, and the enzymes involved in, hydrogen/sulfur transformation by hyperthermophilic archaebacteria. Efforts will focus primarily on the autotrophic bacterium, Pyrodictium brockii, which has a reported optimum growth temperature (105°C) in pure culture. Biochemical and genetic characterization of enzymes involved in hydrogen/sulfur transformations for these organisms will be pursued. These include the H_2-activating hydrogenase enzyme, a ubiquinone, a c-type cytochrome, and the S-reducing complex. Comparisons of the biochemical and genetic properties of these electron transport components will be made with mesophilic counterparts. Characterization of both purified hydrogenase and the cloned hydrogenase gene will receive a major research effort. The long-term goal is to understand the biochemical basis of extreme thermophily.

5506 Medicine

Refer also to citation(s) 32907, 33196

33212 (BNL–44536) **Gallium a unique anti-resorptive agent in bone: Preclinical studies on its mechanisms of action.** Bockman, R. (Hospital for Special Surgery, New York, NY (USA)); Adelman, R.; Donnelly, R.; Brody, L.; Warrell, R.; Jones, K.W. Brookhaven National Lab., Upton, NY (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-9005170–1: 1. internatonal symposium on metal ions in biology and medicine, Champagne (France), 16-19 May 1990). Order Number DE90010650. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The discovery of gallium as a new and unique agent for the treatment of metabolic bone disorders was in part fortuitous. Gallium is an exciting new therapeutic agent for the treatment of pathologic states characterized by accelerated bone resorption. Compared to other therapeutic metal compounds containing platinum or germanium, gallium affects its antiresorptive action without any evidence of a cytotoxic effect on bone cells. Gallium is unique amongst all therapeutically available antiresorptive agents in that it favors bone formation. 18 refs., 1 fig.

33213 (DOE/ER/60871–1) **Positron Emission Tomography with improved spatial resolution: The ninth months technical report.** Drukier, A.K. Applied Research Corp., Landover, MD (USA). Apr 1990. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-89ER60871. Order Number DE90011444. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Applied Research Corporation (ARC) proposed the development of a new class of solid state detectors called Superconducting Granular Detectors (SGD). These new detectors permit considerable improvements in medical imaging, e.g. Positron Emission Tomography (PET). The biggest impact of this technique will be in imaging of the brain. It should permit better clinical diagnosis of such important diseases as Altzheimer's or schizophrenia. More specifically, we will develop an improved PET-imager; a spatial resolution 2 mm may be achievable with SGD. A time-of-flight capability($t \approx 100$ psec) will permit better contrast and facilitate 3D imaging. In the following, we describe the results of the first 9 months of the development.

33214 (LA-UR–90-1438) **Expert systems for flow cytometry data analysis: A preliminary report.** Salzman, G.C. (Los Alamos National Lab., NM (USA)); Stewart, C.C.; Duque, R.E. Los Alamos National Lab., NM (USA). [1990]. 8p. Sponsored by U.S. Department of Health and Human Services. DOE Contract W-7405-ENG-36. (CONF-900140–24: SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition, Los Angeles, CA (USA), 15-19 Jan 1990). Order Number DE90010619. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Flow Cytometry has become an accepted technique in the clinical laboratory for rapid immunophenotyping of patient blood samples. Multiple, fluorescent labeled monoclonal antibodies are used to tag the cells, which are then analyzed one at a time at rates of several thousand cells a second. Patient samples are processed through the flow cytometer at more than one a minute. Clinicians are being overwhelmed by the large amount of data that must be analyzed to provide the information needed to assist in disease diagnosis. An expert system is being developed to assist clinicians in analyzing this multivariate flow cytometry data. The data from each sample are processed by a clustering algorithm, which finds the means of the distinct cell subpopulations in a sample. These mean values of fluorescence are translated into words such as "negative," "dim" and "bright" and the words are combined into patterns that are matched against the premises on the left hand side of the rules used to identify the disease categories. This is a report of work in progress. 13 refs., 4 figs.

5507 Microbiology

Refer also to citation(s) 32055, 32056, 32067, 32267, 33139

33215 (CONF-900512–2) **Hydrolysis of cellobiose by immobilized β-glucosidase entrapped in maintenance-free gel spheres.** Woodward, J.; Clarke, K.M. Oak Ridge National Lab., TN (USA). [1990]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 12. symposium on biotechnology for fuels and chemicals; Gatlinburg, TN (USA); 7-11 May 1990. Order Number DE90010701. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A crude preparation of Aspergillus niger β-glucosidase(27.5 cellobiase units mg^{-1}protein at 40°C, pH 5.0) was immobilized on concanavalin A-Sepharose (CAS). The cellobiase activity of the immobilized enzyme was 1334 units mg^{-1} dried CAS or 108 units mL^{-1} of CAS gel. The β-glucosidase-CAS complex was entrapped within cross-linked propylene glycol alginate/bone gelatin gel spheres that possessed between 0.67 and 2.35 cellobiase units mL^{-1} spheres depending on their size. The effect of cellobiase concentration (10 to 300 mM) on the activity of native, immobilized, and gel-entrapped enzyme was determined and found that concentrations of cellobiase between 10 and 180 mM cellobiase were not inhibitory to the entrapped enzyme, unlike that found to occur with the native and immobilized enzyme. Exogenous ion addition was not necessary to maintain the structural integrity of the spheres which were stable for 4 days at 40°C. 9 refs., 3 figs.

5510 Physiological Systems

Refer also to citation(s) 33259, 33260

5520 Public Health

33216 The study of drugs of abuse with an ion trap mass spectrometer. Asano, K.G. (Oak Ridge National Lab., TN (USA). Analytical Chemistry Div.); Glish, G.L.; McLuckey, S.A. 1-1 of Pittsburgh conference 1989 and exposition on analytical chemistry and

applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 720.

The authors have recently begun to use the Finnigan Ion Trap Mass Spectrometer (ITMS) for the study of the mass spectrometry of a variety of drugs, including drugs of abuse such as cocaine and marihuana. The ITMS is an extremely powerful tool for this purpose due to the wide range of experiments that can be used to form and investigate ions from drugs. The authors have used several means for forming ions from drugs including electron ionization, proton transfer chemical ionization, and electron transfer chemical ionization. In the latter two modes, mass-selected reagent ions were used to afford greater control over the ion/molecule chemistry that occurs in the trap. The usefulness of this approach relative to the chemical ionization without reagent ion mass selection is demonstrated with promethazine. Mass selected reagent ion chemical ionization permits mass spectra to be acquired at a variety of internal energies, both for the molecular ions and for the protonated molecules, without complications from other reactive species often present in conventional chemical ionization.

5530 Agriculture and Food Technology

Refer also to citation(s) 32092, 33193, 33839

33217 (CNIC–00199) **Possibility of rubidium-86 as a tracer of potassium and its application in agriculture as a tracer.** Zheng Weimin (Hebei Agricultural Univ., Baoding (China)); Yang Fucun; Wu Zhenying; Lou Hai. China Nuclear Information Centre, Beijing, BJ (China). Apr 1988. 20p. (In Chinese). (U03-HAU–0019). Order Number DE90627998. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The correlation analysis for the absorption and the distribution of ^{86}Rb and K and K by plant and their movements in the soil showed that the correlation is significant at each growing period of the plant, but their movement correlation in the soil is affected by the texture of soil and water conditions. The experiment with the tracer ^{86}Rb showed taht the movements of K(^{86}Rb) in the directions of length and breadth are slow in soil. The texture of soil and water condition affect on the movemet and fixation of K(^{86}Rb) in soil. The law of absorption of ^{86}Rb (K) by tomato, corn, sorghum, rad bean and kenaf etc. provides scientific basis for the proper fertilization.

33218 (NMRDI–2-78-5202) **Comparative performance analysis: Commercial cut-flower rose production.** Whittier, J.; Fischer, C.L. Southwest Technology Development Inst., Las Cruces, NM (USA). Apr 1990. 121p. Sponsored by New Mexico Research and Development Institute. Order Number DE90011199. Available from NTIS, PC A06/MF A01; OSTI; NMRDI, Communications Office, Suite M, 457 Washington SE, Albuquerque, NM 87108.

A comparative performance analysis has been conducted to examine the various factors associated with establishing and operating a commercial rose cut-flower greenhouse in ten different locations across the United States. Plant productivity, defined as net blooms produced per plant per year, is largely dependent upon local climatic conditions and technological improvements. Regional variations in productivity have been explicitly analyzed. The greenhouse operation is assumed to be four acres in size and the facilities utilize current technologies. The operation is designed as a professionally-organized company with an owner/manager, grower, and salesperson. The primary product is a red hybrid tea rose for sales. Selling markets vary by location, but in general they are large metropolitan areas. The analysis strongly indicates that new installations for cut-flower rose production are profitable in several areas in the U.S. Southwest, particularly in New Mexico, Arizona, and Texas. No ones stands out as a favored location. Las Cruces, New Mexico, has the highest net present volume and return on investment results. 68 refs., 1 fig., 8 tabs.

33219 (PNL–7332) **Effects of valley meteorology on forest pesticide spraying.** Whiteman, C.D. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 23p. Sponsored by U.S. Department of the Interior. DOE Contract AC06-76RL01830. Order Number DE90010858. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Pacific Northwest Laboratory conducted this study for the Missoula Technology and Development Center of the US Department of Agriculture's Forest Service. The purpose of the study was to summarize recent research on valley meteorology during the morning transition period and to qualitatively evaluate the effects of the evolution of valley temperature inversions and wind systems on the aerial spraying of pesticides in National Forest areas of the western United States. Aerial spraying of pesticides and herbicides in forests of the western United States is usually accomplished in the morning hour after first light, during the period known to meteorologists as the "morning transition period." This document describes the key physical processes that occur during the morning transition period on undisturbed days and the qualitative effects of these processes on the conduct of aerial spraying operations. Since the timing of valley meteorological events may be strongly influenced by conditions that are external to the valley, such as strong upper-level winds or the influence of clouds on the receipt of solar energy in the valley, some remarks are made on the qualitative influence of these processes. Section 4 of this report suggests ways to quantify some of the physical processes to provide useful guidance for the planning and conduct of spraying operations. 12 refs., 9 figs.

56 BIOMEDICAL SCIENCES, APPLIED STUDIES

5601 Radiation Effects

Refer also to citation(s) 33117, 33123, 33138

33220 (BMVg-FBWM–90-8) **Investigations on the detection and prevention of DNA-lesions induced by ionizing irradiation.** Nehls, P.; Kohfeldt, E.; Lang, T.; Karwowski, M.; Sauer, S.; Stadtkus, C. Bundesministerium der Verteidigung, Bonn (Germany, F.R.). Abt. Wehrtechnik; Ulm Univ. (Germany, F.R.). Abt. Pathologie. 1990. 39p. (In German). Contract BMVg-InSan I 0186-V-4391. Available from Bundesministerium der Verteidigung, Bonn (Germany, F.R.). Dokumentations- und Fachinformationszentrum der Bundeswehr (DOKFIZBw).

Two different antigens were synthesized to raise monoclonal antibodies (Mab) against thymineglycol (5,6-dihydroxy-6-hydrothymine). Balb/c mice were immunized with one antigen, poly (dA-dT) treated with osmium etroxide. The second antigen, thymidineglycol-5'-monophosphate, is currently beeing analyzed by NMR spectroscopy. Using a Mab directed against O^6-ethylguanine we established a rapid and highly sensitive assay for quantitation of the capacity for cellular repair of specific DNA lesions. Using this assay the level of O^6-ethylguanine-DNA-alkyltransferase in mouse fibroblast cells was found to be raised transiently after treatment of the cells with ionizing irradiation. We are also establishing other assays for the study of the formation and repair of DNA lesions at the sequence level. (orig.).

33221 (CONF-8910367–2) **JANUS neutron irradiation of a mouse cell line containing a shuttle vector plasmid.** Nagy, B. (Central Inst. for Tumors, Zagreb (Yugoslavia)); Grdina, D.J.; Ashman, C.R. Argonne National Lab., IL (USA). [1989]. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 3. international conference of anticarcinogens and radiation protection; Dubrovnik (Yugoslavia); 15-21 Oct 1989. Order Number DE90010542. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The study presented here represents the initial steps of our attempt to characterize JANUS neutron induced mutagenesis in mammalian cells. The approach which we are taking is to use a mammalian cell system which allows one to determine the actual changes in DNA base sequence which occur when a gene mutates. Recently, several systems have been described which make possible the rapid and unambiguous determination of DNA base sequence changes in genes of eukaryotic cells. In some of these systems, a target gene is introduced into the mammalian cells as

part of a shuttle vector which is capable of replication in both mammalian cells and bacteria. In this study we have used such a system for the analysis of neutron-induced mutations in the presence and absence of the radioprotector N-(2-mercaptoethyl)-1,3-diaminopropane, WR1065. 20 refs., 5 figs., 1 tab.

33222 (EGG-BNCT–8777-Vol.4-No.3) **PBF/BNCT [Power Burst Facility/Boron Neutron Capture Therapy] Program for Cancer Treatment: Monthly bulletin, Volume 4, No. 3.** Dorn, R.V. III. EG and G Idaho, Inc., Idaho Falls, ID (USA). Mar 1990. 30p. Sponsored by U.S. DOE Energy Research. DOE Contract AC07-76ID01570. Order Number DE90010954. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Highlights of the PBF/BNCT (Power Burst Facility/Boron Neutron Capture Therapy) during March 1990 include progress within the areas of: gross boron analysis in tissue, blood, and urine, analytical methodologies development for BSH (Borocaptate Sodium) purity determination, dosimetry, analytical radiation transport and interaction modeling for BNCT, large animal model studies, neutron source and facility preparation, administration and common support, PBF operations.

33223 (LMF–121) **Inhalation Toxicology Research Institute annual report, October 1, 1987–September 30, 1988.** Mewhinney, J.A.; Bechtold, W.E.; Sun, J.D.; Coons, T.A. (eds.). Lovelace Biomedical and Environmental Research Inst., Albuquerque, NM (USA). Inhalation Toxicology Research Inst. Dec 1988. 661p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76EV01013. Order Number DE90010185. Available from NTIS, PC A99/MF A01 - OSTI; GPO Dep.

The mission of the Inhalation Toxicology Research Institute is to investigate the nature and magnitude of human health effects that result from the inhalation of airborne materials at home, in the work place, or in the general environment. Diseases of the respiratory tract are major causes of suffering and death, and many of these diseases are directly related to the materials that people breathe. The Institute's research is directed toward obtaining a better understanding of the basic biology of the respiratory tract and the mechanisms by which inhaled materials produce respiratory disease. Special attention is focused on studying the airborne materials released by various energy technologies, as well as those associated with national defense activities. The research uses a wide-ranging, comprehensive array of investigative approaches that are directed toward characterizing the source of the airborne material, following the material through its potential transformation in the air, identifying the mechanisms that govern its inhalation and deposition in the respiratory tract, and determining the fate of these inhaled materials in the body and the health effects they produce. The ultimate objectives are to determine the roles played by inhaled materials in the development of disease processes and to estimate the risk they pose to humans who may be exposed to them.

33224 (LMF–126) **Inhalation Toxicology Research Institute annual report, October 1, 1988–September 30, 1989.** Bechtold, W.E.; Nikula, K.J.; Coons, T.A. (eds.). Lovelace Biomedical and Environmental Research Inst., Albuquerque, NM (USA). Inhalation Toxicology Research Inst. Dec 1989. 321p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76EV01013. Order Number DE90010255. Available from NTIS, PC A13/MF A01 - OSTI; GPO Dep.

The Inhalation Toxicology Research Institute (ITRI) is a Federally Funded Research and Development Center operated for the US Department of Energy (DOE) by the Lovelace Biomedical and Environmental Research Institute. The mission of ITRI is to conduct basic and applied research to improve our understanding of the nature and magnitude of the human impacts of inhaling airborne materials in the home, workplace, and general environment. The Institute's research programs have a strong basic science orientation with emphasis on the nature and behavior of airborne materials, the fundamental biology of the respiratory tract, the fate of inhaled materials and the mechanisms by which they cause disease, and the means by which data produced in the laboratory can be used to estimate risks to human health. Disorders of the respiratory tract continue to be a major health concern, and inhaled toxicants are thought to contribute substantially to respiratory morbidity. As the largest laboratory dedicated to the study of basic inhalation toxicology, ITRI provides a national resource of specialized facilities, personnel, and educational activities serving the needs of government, academia, and industry. The papers in this report are organized along topical lines, rather than by research program, so that research within specific disciplines is more readily identified. In contract to previous Annual Reports, the papers include summaries of research funded by both DOE and non-DOE sources, to more fully represent the scope of the Institute's activities. The source of funding is acknowledged for each paper. One section consists of summaries of research on the effects of injected actinides, conducted for DOE at the University of Utah.

33225 (ORNL/FTR–3600) **[Radiological protection of the public from intakes of radionuclides]: Foreign trip report, April 21, 1990–April 27, 1990.** Leggett, R.W. Oak Ridge National Lab., TN (USA). 4 May 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90011041. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler participated in a meeting of the International Commission on Radiological Protection (ICRP) Task Group on Age-Dependent Doses to Members of the Public from intakes of Radionuclide (Task Group AGDOS). The meeting was held April 23–27, 1990, at the Chateau de Cadarache in Cadarache, France. The purpose of this meeting was to work on a draft version of Part 2 of ICRP Publication 56 on doses to members of the public from intakes of selected radioisotopes of S, Co, Ni, Zn, Mo, Tc, Ag, Te, Ba, Ra, Pb, and Po. Until the last few years, the work of the ICRP has been directed primarily toward development of guidelines for protection of radiation workers. The need for internationally accepted dose conversion factors for intakes of radionuclides by children and other subgroups of the population has been recognized by the ICRP for several years but became particularly evident after the Chernobyl reactor accident. The ICRP Task Group AGDOS was formed in 1987 to develop such dose factors for potentially harmful radionuclides that might be released to the environment due to various human activities such as mining and milling, conversion, enrichment, fabrication, power station operation, fuel reprocessing, waste storage, and waste disposal.

33226 (PB–90-171562/XAB) **Annual report on the administration of the Radiation Control for Health and Safety Act of 1968, Public Law 90-602, (1988), April 1, 1989. Annual report.** Food and Drug Administration, Rockville, MD (USA). Center for Devices and Radiological Health. 1 Apr 1989. 70p. (FDA/CDRH–90/22). Available from NTIS, PC A04/MF A01.

The Secretary of Health and Human Services is required by Subpart 3, Part F of Title III of the Public Health Service Act; 42 USC 263b et seq. (Public Law 90-602) to submit an annual report to the President for transmittal to the Congress on or before April 1 on the administration of the Radiation Control for Health and Safety Act. The detailed information required in the report is outlined in Section 360D of the Public Health Service Act. The Food and Drug Administration, through its Center for Devices and Radiological Health, is responsible for the day-to-day administration of the Radiation Control for Health and Safety Act of 1968. The report provides a summary of the operations of the Center in carrying out that responsibility for calendar year 1988. In reviewing the operations of the Center for Devices and Radiological Health as reported in the document, it should be kept in mind that the day-to-day administration of the Act is only part of the Center's function. Other responsibilities include the administration and enforcement of the 1976 Medical Device Amendments to the Federal Food, Drug, and Cosmetic Act (not covered in the report).

33227 (RERF-TR–3-89) **Smoking and serum proteins in atomic bomb survivors in Hiroshima.** Stram, D.O.; Akiba, Suminori; Neriishi, Kazuo; Hosoda, Yutaka; Stevens, R.G. Radiation Effects Research Foundation, Hiroshima (Japan). Sep 1989. 10p. Order Number DE90791086. Available from NTIS (US Sales Only), PC A02/MF A01.

Associations of smoking habit with serum levels of total protein as well as protein fractions were studied in a population consisting of 4,739 atomic bomb survivors and unexposed control subjects in Hiroshima who participated in the 1979-81 period of the Adult Health Study, an on-going health follow-up program of the RERF.

Smoking was strongly related to serum protein concentration after correction for age, sex, and body mass index. Among current smokers as compared to nonsmokers, levels of total protein, β globulin, and γ globulin were significantly lower ($p<0.001$), and levels of α_1 and α_2 globulin were significantly higher ($p<0.001$). For serum albumin levels, a decrease was also noted but it failed to attain statistical significance. Exsmokers were indistinguishable from nonsmokers in terms of the serum protein levels analyzed in this paper. With an increase in daily cigarette consumption, monotonic increases of serum levels were observed only in α_1 globulin. Duration of smoking (years) was related to increased α_1 and α_2 globulin. Smoking duration was also associated with albumin level but the trend was not monotonic. The radiation exposure effect on serum protein level was significant in several instances but was in general much smaller than the smoking effect. Its inclusion in the regression models did not noticeably affect the association between smoking and serum proteins. (author).

33228 (RERF-TR-4-89) **Radiation-related posterior lenticular opacities in Hiroshima and Nagasaki atomic bomb survivors based on T65DR and DS86 dosimetry systems.** Otake, Masanori; Schull, W.J. Radiation Effects Research Foundation, Hiroshima (Japan). Oct 1989. 28p. Order Number DE90791085. Available from NTIS (US Sales Only), PC A03/MF A01.

This paper investigates the quantitative relationship of ionizing radiation to the occurrence of posterior lenticular opacities among the survivors of the atomic bombings of Hiroshima and Nagasaki, as suggested by the DS86 dosimetry system. DS86 doses are available for 1,983 (93.4%) of the 2,124 A-bomb survivors analyzed in 1982. In the DS86 system, both gamma-ray and neutron regression coefficients for the best-fitting model are positive and highly significant for the estimated energy deposited in the eye, here termed the eye organ dose. The DS86 gamma regression coefficient is almost the same as that associated with the T65DR gamma kerma, the ratio of the two coefficients being 1.1 (95% confidence limits: 0.5 - 2.3) for D86 kerma in the individual data. The relative biological effectiveness (RBE) values based on the individual gamma and neutron components of the DS86 eye organ dose are estimated to be $32.4 + 0.73/(D_\nu - 0.06)>0$ with the 95% confidence limits ranging from 11.8 to $88.8 + 1.39/(D_\nu - 0.06)>0$, where D_ν is the neutron dose in gray. It is suggested that the neutron component could be more important for the eyes than for other sites of the body. Finally, it is interesting to observe that a linear-quadratic gamma and linear neutron model with two thresholds, which fits the data less well, produces very similar estimates of the two thresholds as the linear gamma-linear neutron-response model. In this model, however, the regression coefficient is not significantly associated with the quadratic gamma response. (J.P.N.).

33229 (RERF-TR-7-89) **The shape of the cancer mortality dose-response curve for atomic bomb survivors.** Pierce, D.A.; Vaeth, M. Radiation Effects Research Foundation, Hiroshima (Japan). Oct 1989. 24p. Order Number DE90791087. Available from NTIS (US Sales Only), PC A03/MF A01.

The shape of the cancer mortality dose-response in the atomic bomb survivor data is analyzed in the context of linear-quadratic (LQ) models. Results are given for all cancers except leukemia as a group, for leukemia, and for combined inferences assuming common curvature. Since there is substantial information aside from these data suggesting a dose-response concave from above, the emphasis here is not on estimating the best-fitting dose-response curve, but rather on assessing the maximal extent of curvature under LQ models which is consistent with the data. Such inferences are substantially affected by imprecision in the dose estimates, and methods are applied which make explicit allowances for biases due to this. The primary means used here to express the extent of curvature is the factor by which linear risk estimates should be divided to arrive at appropriate low-dose risk estimates. In the past, influential committees have recommended ranges of 2-10 and of 1.5-3 for such a factor. Results here suggest that values greater than about 2 are at least moderately inconsistent with these data, within the context of LQ models. It is emphasized, however, that there is little direct information in these data regarding low-dose risks; the inferences here depend strongly on the link between low-dose and high-dose risks provided by the assumption of an LQ model. (author).

33230 (UCRL-21223-App.) **Lawrence Livermore National Laboratory RCRA Part B health risk assessment: Phase 2, Hazardous waste management units: Appendices.** Lawrence Livermore National Lab., CA (USA); Radian Corp., Sacramento, CA (USA). 20 Feb 1990. 557p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010762. Available from NTIS, PC A24/MF A01 - OSTI.

This volume contains brief toxicological summaries composed from the references where the doses and cancer potency values were found or from which information used to derive the doses was found. The majority of the reference doses were taken from or derived from the data in the health Affects Assessment Tables or the Threshold Limit Values and Biological Exposure Indices. Calculations for derived informal reference doses appear in Appendix C.

33231 **Measurement of free ammonia produced by X irradiation of glycylglycine in aqueous solution.** Yoshida, H. (Oak Ridge National Lab., TN (USA)); Bolch, W.E.; Jacobson, K.B.; Turner, J.E. *Radiation Research (USA),* 121(3): 257-261 (Mar 1990).

This research was initiated to test the validity of predictions based on Monte Carlo calculations of the effect of ionizing radiation on a simple dipeptide. The mechanism for the formation of ammonia, proposed by Garrison, Sokol, and Bennett-Corniea, was reevaluated by measuring the yields under deoxygenated and oxygenated conditions. Although free ammonia was formed under both conditions, the yields were different, depending on the concentrations of solute and molecular oxygen. The reaction probabilities of the specific interactions of free radicals formed in pure water with solute and oxygen are discussed to account for the observed difference. Our results obtained after low-dose-rate X irradiation are compared with those obtained by Garrison et al. after high-dose-rate 60Co gamma irradiation.

5603 Chemicals Metabolism and Toxicology

Refer also to citation(s) 32151, 32157, 33073, 33074, 33075, 33077, 33085, 33095, 33113, 33142, 33145, 33148, 33181, 33183, 33187, 33190, 33197, 33230

33232 (KFK-4649) **Morphological and biochemical investigations into the effects of quartz on bovine alveolar macrophages (BAM) and their organelles.** Paetzold, S. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Genetik und Toxikologie von Spaltstoffen; Karlsruhe Univ. (T.H.) (Germany, F.R.). Fakultaet fuer Bio- und Geowissenschaften. Oct 1989. 142p. (In German). Order Number DE90792515. Available from NTIS (US Sales Only), PC A07/MF A01.

Investigations into the toxicity of quartz were carried out in bovine alveolar macrophages cultivated in vitro. Control incubations with titanium(IV) oxide showed that cultivated BAM are prone to enzyme release and pronounced vacuolation of cells. When they were incubated with native quartz morphological changes could be detected after no less than two hours. The action of native quartz was clearly related to the duration of incubation. It not only led to a dramatic reduction of cell viability but also invited an abundant release of cytoplasmic and lysosomal enzymes (LDH and NAG) and proteins into the culture medium, while there was on the other hand a considerable impairment of the overall activity of cathepsin B. The occurrence of the latter effect was restricted to those cells, by which quartz had been ingested and deposited. At the intracellular level native quartz acted to redistribute the lysosomal enzyme activity in such a way that the function of the 'ML' fraction was taken over by the 'N' and 'S' fractions. The latency of lysosomes isolated from control cells remained unchanged following in vitro incubation with quartz, even though there was a spontaneous, dosedependent adsorption of lysosomes to quartz particles. Previous treatment of the quartz compound using alpha-phosphatidyl-choline-dipalmitoyl (DPL) ensured complete protection of the cells against cytotoxic effects for up to 90 hours. (orig./MG).

33233 (KFK-PEF-60) **Progeny test of Norway Spruce stands in the Black Forest (areas of origin 840 06 and 840 09)**

aiming at: 1. Improvement of immission tolerance. 2. Conservation of genetic resources of damaged stands in high altitudes ('Gene Bank'). Franke, A. (Forstliche Versuchs- und Forschungsanstalt Baden-Wuerttemberg, Freiburg im Breisgau (Germany, F.R.)); Konnert, M. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF). Mar 1990. 95p. (In German). Contract PEF 84/046/1A. Order Number DE90792554. Available from NTIS (US Sales Only), PC A05/MF A01.

Considering continuous forest damage caused by air pollutants a progeny test of Norway Spruce stands (Picea abies (L.) Karst.) of the Black Forest was started in 1985. New facts about indigenous stands are expected as well as facts about vitality, fitness and perhaps immission tolerance of the tested stands. First measures for preserving genetic diversity of Norway Spruce in the Black Forest were taken. The results of seedling identification-tests, early tests and isozyme analysis are presented and interpreted. The project will be continued. (orig.) With 4 figs., 23 tabs., 56 refs.

33234 (LA-UR-90-1329) **Health and safety guide for inorganic compounds and metals used in the fabrication of superconductive alloys.** Arnold, S.D.; Talley, G.M. Los Alamos National Lab., NM (USA). Spr 1990. 64p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-9004192–1: Society for Occupational and Environmental Health annual conference, Bethesda, MD (USA), 23-25 Apr 1990). Order Number DE90010598. Available from NTIS, PC A04/MF A01 - OSTI.

This health and safety guide was written to satisfy two objectives: to summarize the toxicity of metals and alloys used in superconductivity for the benefit of those who work with these materials, and to summarize and describes the basic principles of a highly technical field from a health and safety point-of-view for the benefit of health professionals. The guide begins with a profile of the superconductivity industry, including a list of current and potential applications, a literature review of the market potential, and summary of the current industry status. The body of the paper provides a toxicity and hazard summary for 50 metals, alloys and metal oxides used in superconductivity. The toxicity and hazard summary for all 50 compounds includes: occupational exposure limits, explosiveness and flammability potential, LD_{50}'s, chemical and physical properties, incompatibilities and reactivities, recommended personal protective equipment, symptoms of acute and chronic exposure, target organs and toxic effects, and steps for emergency first aid. Finally, a discussion of general occupational hygiene principles is provided, with emphasis on how these principles apply to the unique field of superconductivity. 41 refs.

33235 (PB–90-164021/XAB) **Comparison of serum levels of 2,3,7,8-tetrachlorodibenzo-p-dioxin with indirect estimates of Agent Orange exposure among Vietnam veterans. Final report.** Centers for Disease Control, Atlanta, GA (USA). Center for Environmental Health and Injury Control. Sep 1989. 169p. Available from NTIS, PC A08/MF A01.

The report tests the validity of several indirect methods for estimating the exposure of ground troops to Agent Orange in Vietnam during 1966-69. The study identified a sample of U.S. Army Vietnam veterans of that era and asked them to have blood drawn so that the level of 2,3,7,8-tetrachlorodibenzo-p- dioxin (TCDD) in serum could be measured. These veterans were selected from among those who served in 65 combat battalions in III Corps, a heavily sprayed part of Vietnam around Saigon. The men selected had all served only one tour in Vietnam and had been discharged with a pay grade of E1-E5, after having spent, on the average, over 300 days in Vietnam. The sample was chosen after the veterans had been stratified on likelihood of exposure (time and space proximity to recorded sprays) according to military records. For comparison, a sample of non-Vietnam U.S. Army veterans of the same era was also examined. The results show no meaningful association between TCDD levels and indirect estimate of Agent Orange exposure in Vietnam, with or without adjustment for other characteristics of the veterans, including age, race, body mass index, and self-reported civilian occupational and home herbicide exposure.

33236 (PB–90-179102/XAB) **Health-hazard evaluation report HETA 89-007-1983, St. Thomas More Hospital, Canyon City, Colorado.** Daniels, W.J. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Div. of Surveillance, Hazard Evaluation and Field Studies. Sep 1989. 25p. (HETA–89-007-1983). Available from NTIS, PC A03/MF A01.

St. Thomas More Hospital, Canyon City, Colorado was evaluated for possible health hazards to workers due to exposure to waste anesthetic gases in the operating rooms of the hospital. Exposures to ethylene oxide used in gas sterilization, formaldehyde used in the morgue, and organic solvents used in the histology laboratory were investigated. The 81-bed hospital was housed in a two-story building with a basement. Five of the samples for nitrous oxide had a mean of 0.23 ppm and halothane had a mean of 0.15 ppm. Toluene and isopropyl alcohol were below their limits of detection. Formaldehyde was found at a time weighted average concentration of 4.8 ppm, which was above the permissible exposure level of 2.0 ppm as a 15-minute ceiling. The report concludes that at the time of the survey the potential did exist for overexposure to waste anesthetic gases and vapors and formaldehyde. Specific measures to be taken to control employee exposures are recommended.

33237 (PB–90-179128/XAB) **NIOSH (National Institute for Occupational Safety and Health) testimony on asbestos by R. A. Lemen on March 21, 1984.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 21 Mar 1984. 11p. Available from NTIS, PC A03/MF A01.

The testimony discussed the work conducted by the National Institute for Occupational Safety and Health (NIOSH) concerning protection for workers exposed to asbestos (1332214). All commercial forms of asbestos were considered to be carcinogenic. Exposure to asbestos significantly increased the risk of contracting asbestos, lung cancer, and mesothelioma. Asbestos was one of the primary causes of lung cancer in nonsmokers. It was estimated that since the beginning of World War II as many as eight million workers have been exposed to asbestos. Over one million currently worked where exposure may be a problem. Construction workers involved in the demolition of buildings containing asbestos insulation were at increased risk of developing asbestos-related disease. Maintenance personnel often repaired machines in asbestos-contaminated work spaces or worked directly with products containing asbestos. NIOSH programs have involved measuring and characterizing asbestos fibers found in the work environment, quantification of the extent of disease among workers through epidemiological studies, and supporting these study results with toxicological experiments. NIOSH has also sponsored educational programs for the public and the training of workers to alert individuals to the dangers of asbestos.

33238 (PB–90-179144/XAB) **NIOSH (National Institute for Occupational Safety and Health) testimony on dioxin by J. D. Millar on November 9, 1983.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 9 Nov 1983. 8p. Available from NTIS, PC A02/MF A01.

The testimony concerned studies conducted by the National Institute for Occupational Safety and Health (NIOSH) related to long term health consequences among workers exposed to dioxin contaminated products. The Dioxin Registry and Mortality Study was summarized exploring the relationship between soft tissue sarcoma and dioxin exposure. A cohort of workers was identified through this registry who are known to have worked in chemical processes which generated dioxin. This group constitutes a unique population of persons with documentation of potential exposure to dioxin among whom meaningful epidemiological observations can be made. An extensive review was also made of medical literature concerning the link between exposure to dioxin and soft tissue sarcoma. Several clinical cases of soft-tissue sarcoma were observed among Swedish lumberjacks previously exposed to dioxin-contaminated products. Similar studies were conducted in the United States among workers exposed to the herbicide 2,4,5-trichlorophenoxy-acetic-acid or its chemical precursor, trichlorophenol. The results of these studies were not considered to confirm a link between dioxin and soft-tissue sarcoma, but they did provide sufficient reason for continuing the study.

33239 (PB–90-179292/XAB) **Health-hazard evaluation report HETA 87-371-1986, technical assistance to the Jamaican Ministry of Health, Kingston, Jamaica.** Matte, T.D.; Burr, G.A. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Sep 1989. 48p. (HETA–87-371-1986). Available from NTIS, PC A03/MF A01.

A study was made of lead exposure at three-battery manufacturing facilities in Kingston, Jamaica: Tropical Battery with approximately 30 production workers, Apex Battery with 12 workers, and Unistate Battery with five production workers. Each of the three companies was in the process of conducting limited medical screening of their production workers. Full-shift personal breathing-zone air samples for lead ranged from 40 to 5300 micrograms/cubic meter (microg/cu m), from 50 to 3400 microg/cu m, and from 30 to 190 microg/cu m at the three locations, respectively. Operations with the highest lead exposures included the plate separator and battery assembly and they exceeded the OSHA permissible exposure limit of 50 microg/cu m. Blood samples indicated blood lead levels in seven of 29 employees at Tropical were over the recommended medical removal level of 50 micrograms/deciliter (microg/dl) and that 17 of 29 had levels of 40 microg/dl or greater. For the Apex facility the blood lead levels in nine of 12 workers were 60 microg/dl or greater. Blood samples from three of four production employees tested at Unistate exceeded 60 microg/dl. The report concludes that a high risk of lead toxicity existed among workers at the battery manufacturers surveyed. General and local exhaust ventilation should be provided, work practices altered to reduce lead exposure, and respiratory protection programs should be implemented.

33240 (PB–90-180746/XAB) **Industrial-hygiene walk-through report, Cyprus Industrial Minerals Company, Bay Street Mill, Los Angeles, California.** Ludwig, H.R.; Sandusky, T.E. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Div. of Surveillance, Hazard Evaluation and Field Studies. 22 Jul 1976. 11p. (IWS–036-23). Available from NTIS, PC A03/MF A01.

A walk-through survey was conducted at the Cyprus Industrial Minerals Company, Los Angeles, California as part of a study to characterize talc used in the United States. Cyprus Mines acquired its present site in 1964. The mill has been in operation since 1919 and graded different blends and grades of talc for use in paints and tile. Nine employees work at the site during two or three shifts per day. Stockpiled talc was fed into the crusher where it was conveyed by elevator to a bin, and then dropped through a Raymond Roller mill before being bagged. If a finer product was required, the talc was also passed through a Raymond Vertical mill before bagging. The employees were potentially exposed to noise and excessive dust. The personnel records at this site included social security numbers, work histories and the lost time accident data back to at least 1964. An audiometric hearing program should be instituted to determine the effectiveness of the current hearing protection program. Dust levels in the air should be reduced by increasing the exhaust ventilation around the packing machines.

33241 (PB–90-181249/XAB) **Toxicological profile for phenol. Final report.** Clement Associates, Inc., Fairfax, VA (USA). Dec 1989. 121p. Available from NTIS, PC A06/MF A01.

Also available from Supt. of Docs.

The ATSDR Toxicological Profile for Phenol is intended to characterize succinctly the toxicological and health effects information for the substance. It identifies and reviews the key literature that describes the substance's toxicological properties. Other literature is presented but described in less detail. The profile is not intended to be an exhaustive document; however, more comprehensive sources of specialty information are referenced. The profile begins with a public health statement, which describes in nontechnical language the substance's relevant toxicological properties. Following the statement is material that presents levels of significant human exposure and, where known, significant health effects. The adequacy of information to determine the substance's health effects is described. Research gaps in nontoxic and health effects information are described. Research gaps that are of significance to the protection of public health will be identified in a separate effort. The focus of the document is on health and toxicological information.

33242 (PB–90-181256/XAB) **Toxicological profile for mercury. Final report.** Clement Associates, Inc., Fairfax, VA (USA). Dec 1989. 178p. Available from NTIS, PC A09/MF A01.

The ATSDR Toxicological Profile for Mercury is intended to characterize succinctly the toxicological and health effects information for the substance. It identifies and reviews the key literature that describes the substance's toxicological properties. Other literature is presented but described in less detail. The profile is not intended to be an exhaustive document; however, more comprehensive sources of specialty information are referenced. The profile begins with a public health statement, which describes in nontechnical language the substance's relevant toxicological properties. Following the statement is material that presents levels of significant human exposure and, where known, significant health effects. The adequacy of information to determine the substance's health effects is described. Research gaps in nontoxic and health effects information are described. Research gaps that are of significance to the protection of public health will be identified in a separate effort. The focus of the document is on health and toxicological information.

33243 (PB–90-181264/XAB) **Toxicological profile for chloroethane. Final report.** Clement Associates, Inc., Fairfax, VA (USA). Dec 1989. 98p. Available from NTIS, PC A05/MF A01.

The ATSDR Toxicological Profile for Chloroethane is intended to characterize succinctly the toxicological and health effects information for the substance. It identifies and reviews the key literature that describes the substance's toxicological properties. Other literature is presented but described in less detail. The profile is not intended to be an exhaustive document; however, more comprehensive sources of specialty information are referenced. The profile begins with a public health statement, which describes in nontechnical language the substance's relevant toxicological properties. Following the statement is material that presents levels of significant human exposure and, where known, significant health effects. The adequacy of information to determine the substance's health effects are described. Research gaps in nontoxic and health effects information are described. Research gaps that are of significance to the protection of public health will be identified in a separate effort. The focus of the document is on health and toxicological information.

33244 (PB–90-181363/XAB) **Fiscal Year 1989 report: Initial performance evaluation of three bioessays modified for direct in-situ testing.** Kapustka, L.A. Environmental Protection Agency, Corvallis, OR (USA). Environmental Research Lab. Feb 1990. 65p. (EPA–600/3-90/021). Available from NTIS, PC A04/MF A01.

Under an Interagency Agreement, the Environmental Research Laboratory-Corvallis has been developing methods for on-site and in situ toxicity testing and planning field validations for these techniques; in particular, these methods are being evaluated for their application to ecological assessments at hazardous waste sites. The report covers activities completed or initiated from July 1, 1989 to Oct 1, 1989.

33245 (PB–90-181454/XAB) **Proposed national strategies for the prevention of leading work-related diseases and injuries: Occupational cancers.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 1986. 20p. (DHHS/PUB/NIOSH–89-130). Available from NTIS, PC A03/MF A01.

Also available from Supt. of Docs. See also PB–90-181447.

The document develops a strategy for the prevention of occupationally induced cancer in workers. An organized and coordinated effort by the various levels of governments and the private sector will be required to implement the national prevention strategy.

33246 (PB–90-183534/XAB) **Workshop report on EPA (Environmental Protection Agency) guidelines for carcinogen risk assessment: Use of human evidence. Held in Washington, DC. on June 26-27, 1989.** Eastern Research Group, Inc., Arlington, MA (USA). Sep 1989. 98p. Available from NTIS, PC A05/MF A01.

Also available from Supt. of Docs.

The U.S. Environmental Protection Agency (EPA) issued guidelines for assessing human risk from exposure to environmental carcinogens. The guidelines set forth principles and procedures to guide EPA scientists in the conduct of Agency risk assessments, to

promote high scientific quality and Agency-wide consistency, and to inform Agency decision makers and the public about these scientific procedures. In publishing the guidance, EPA emphasized that one purpose of the guidelines was to encourage research and analysis that will lead to new risk-assessment methods and data, which in turn would be used to revise and improve the guidelines. Thus, the guidelines were developed and published with the understanding that risk assessment is an evolving scientific undertaking and that continued study would lead to changes.

33247 (PB–90-185216/XAB) **High-performance liquid chromatographic assay of biphenyl metabolism by hepatocytes cultured in an embryo/hepatocyte co-culture medium.** Mole, M.L.; Sanders, L.; Oglesby, L.A. Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab. c 1988. 13p. (EPA–600/J-88/485). Available from NTIS, PC A03/MF A01.

Pub. in Analytical Biochemistry, Vol. 175, 74-84(1988).

A high-performance liquid chromatographic method has been modified for the evaluation of both Phase I and II metabolism of biphenyl by hepatocytes maintained in an embryo/hepatocyte co-culture medium. Extracts of the media, before and after hydrolysis of conjugates, are directly injected onto the HPLC and the major hydroxylated metabolites plus unmetabolized biphenyl are detected by fluorescence after separation under gradient or isocratic conditions. The method is almost free of interferences and is relatively simple and rapid. In the case of monohydroxylated derivatives, the minimum media concentrations which can be measured are 7 to 20 nM (0.07 to 0.2 pmol on-column). Recoveries from culture medium to which known amounts of biphenyl and metabolites had been added were quantitative (90-103%) and the reproducibility good (interassay CV < 5%). The assay was applied to cultures of hepatocytes derived from rabbit and from phenobarbital induced and noninduced rat.

33248 (PB–90-185240/XAB) **Review, discussion, and summary: Toxicology.** Graham, J.A. Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab. c 1989. 6p. (EPA–600/J-89/283). Available from NTIS, PC A02/MF A01.

Pub. in Environmental Health Perspectives, Vol. 70, 191-194(Feb 1989).

The research presented in the toxicology session of the Symposium on the Health Effects of Acid Aerosols significantly advances our understanding of the health effects of acid aerosols and clearly illustrates the importance of animal-inhalation toxicology to risk assessment. The description of the effects of acid on airway-mucus buffering capacity and viscosity helps explain some of the mechanisms responsible for the effects of sulfuric acid on mucociliary clearance and pulmonary function observed in man and animals. Several of the papers illustrate that other pollutants interact with sulfuric acid (H_2SO_4), causing concern about exposure risks and helping in elucidating the effects observed in epidemiology studies that have not yet been duplicated in a laboratory. For example, H_2SO_4 absorbed on zinc oxide (ZnO) particles appears to be about a log more potent than H_2SO_4 alone in causing pulmonary function decrements. Low levels of H_2SO_4 and O_3 were found to be synergistic in increasing collagen synthesis, implying a risk in development of lung fibrosis. More-complex mixtures containing H_2SO_4 cause a variety of interactions, depending upon the end points examined and the chemistry of the mixture. Other reports indicate that dose rate and length of exposure issues are critical to toxicological outcomes.

33249 (PB–90-185257/XAB) **Comparison of age-related changes in in vivo and in vitro measures of testicular steroidogenesis after acute cadmium exposure in the sprague-dawley rat.** Phelps, P.V.; Laskey, J.W. Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab. c 1989. 14p. (EPA–600/J-89/282). Available from NTIS, PC A03/MF A01.

Pub. in Jnl. of Toxicology and Environmental Health, Vol. 27, 95-105(Jan 198).

Previous reports have demonstrated that cadmium- induced testicular necrosis is an age-dependent process. However, little information exists on age-related intestitial cell (IC) damage in the rat after acute exposure to Cd. In-vitro and in-vivo measures of testicular damage were utilized to compare the sensitivity of these measures and to further investigate age-related Cd-induced testicular damage. Testes, epididymides, and seminal-vesicle weights, serum testosterone (sT), hCG-stimulated sT, and basal and stimulated IC testosterone (T) production were compared in rats 21 d following an injection of 2 mg Cd/kg at 9, 37, 67, and 97 d of age. The only Cd-related change noted for immature rats was an 84% reduction in sT. In rats injected when 37 d old, hCG-stimulated sT and epididymides and seminal-vesicle weights, although depressed, were not significantly altered. However, all other measurements were significantly depressed. All measures of testicular damage were significantly depressed in rats injected at 67 and 97 d of age. Overall, in vitro measures were more sensitive indicators of Cd-induced testicular damage than in vivo measures.

33250 (PB–90-187105/XAB) **Metals testing report: Metal content of environmental samples from Region 4.** Kapustka, L.A.; Bollman, M.A.; Baune, W.K. Environmental Protection Agency, Corvallis, OR (USA). Environmental Research Lab. Dec 1989. 16p. (EPA–600/3-90/015). Available from NTIS, PC A03/MF A01.

This report summarizes the procedures used to analyze selected aquatic and emergent plant, aquatic insect, and fish samples for specific metals; and presents the results of the analyses along with some interpretation. Samples were received from Region 4, Environmental Services Division, Athens, Georgia, under an agreement in which the ERL-C Site Assessment Team would determine the metal content of the samples, lead being the primary metal of interest, and forward the results to Region 4 to aid in the site assessments. Samples were collected from two Superfund sites in the southeast United States, the Kassouf-Kimerling site in Tampa, FL, and the Schuylkill site in Plant City, FL. Both were battery cracking sites. The samples were acid digested to reduce them to inorganic constituents which were then analyzed with ICP-AES (inductively-coupled plasma-atomic emission spectroscopy). Metals assessed included calcium, magnesium, sodium, potassium, phosphorus, zinc, aluminum, iron, manganese, copper, chromium, nickel, arsenic, lead, boron, cobalt, and molybdenum.

33251 (PB–90-863473/XAB) **Vinyl chloride and polyvinyl chloride: Toxicology. April 1978-November 1989 (A Bibliography from the Life Sciences Collection data base). Report for April 1978-November 1989.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 141p. Available from NTISPC N01/MF N01.

Supersedes PB–89-855811.

This bibliography contains citations concerning the toxicity of vinyl chloride and polyvinyl chloride following short- and long-term exposures. Metabolism, carcinogenicity, and teratogenitic potential of these substances are considered. Methodologies to quantitate their presence in atmospheric dust and body tissues are discussed. Occupational hazards are also noted. (This updated bibliography contains 323 citations, 12 of which are new entries to the previous edition.)

33252 (PB–90-863481/XAB) **Toxicology of ozone. April 1988-March 1990 (A Bibliography from the NTIS data base). Report for April 1988-March 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 60p. Available from NTISPC N01/MF N01.

Supersedes PB–89-861066.

This bibliography contains citations concerning laboratory and field investigations of the toxic effects of ozone. Topics include effects on forests, agricultural crops, humans, and laboratory animals. Synergism with other atmospheric pollutants such as oxides of sulfur and nitrogen is discussed. Occupational exposure, dosage, and effects on pulmonary and respiratory systems in humans and animals are also presented. (This updated bibliography contains 89 citations, 38 of which are new entries to the previous edition.)

33253 (PB–90-864042/XAB) **Cadmium exposure: Toxicity in humans. April 1978-November 1989 (A Bibliography from the Life Sciences Collection data base). Report for April 1978-November 1989.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 140p. Available from NTISPC N01/MF N01.

Supersedes PB–88-851456.

This bibliography contains citations concerning the effects of cadmium on humans. Biological monitoring of workers exposed to cadmium is discussed in depth. The effects of cadmium on visual-motor performance, community health, and child and infant development are presented. Cadmium as a contributing factor in renal, kidney, and liver diseases, and in infertility is discussed. The effects of smoking on cadmium retention are mentioned. (This updated bibliography contains 321 citations, 36 of which are new entries to the previous edition.)

33254 (PB–90-864075/XAB) **Carbon monoxide toxicity. April 1978-November 1989 (A Bibliography from the Life Sciences Collection data base). Report for April 1978-November 1989.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 107p. Available from NTISPC N01/MF N01.

Supersedes PB–89-858427.

This bibliography contains citations concerning the mechanism and clinical manifestations of carbon monoxide exposure, including the effects on the liver, cardiovascular, and nervous systems. Topics include carbon monoxide binding affinity studies with hemoglobin, measurement of carboxyhemoglobin in humans and various animal species, carbon monoxide levels as related to tobacco and marijuana smoke, occupational exposure and the NIOSH biological exposure index, symptomology and percent of blood CO, and intrauterine exposure. Air pollution, tobacco smoking, and occupational exposure are discussed as primary sources of carbon monoxide exposure. The effects of cigarette smoking on fetal development and health are excluded and examined in a separate bibliography. (This updated bibliography contains 237 citations, 16 of which are new entries to the previous edition.)

33255 (PB–90-864091/XAB) **Toxicity of aromatic polycyclic hydrocarbons. January 1988-October 1989 (A Bibliography from the Life Sciences Collection data base). Report for January 1988-October 1989.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 36p. Available from NTISPC N01/MF N01.

Supersedes PB–89-851893.

This bibliography contains citations concerning the toxicity and biochemical effects of aromatic polycyclic hydrocarbons. Topics include effects on metabolism and liver activity, cellular responses, binding characteristics, and the occurrence and path of the compounds in food chains. Bioaccumulation studies in specific areas, and isolation and detection techniques are also considered. (This updated bibliography contains 60 citations, 10 of which are new entries to the previous edition.)

33256 **Ultratrace determination of formaldehyde in potable water.** Tomkins, B.A. (Oak Ridge National Lab., TN (USA). Analytical Chemistry Div. (USA)); McMahon, J.M.; Caldwell, W.M. 1-1 of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 1236.

Formaldehyde can be leached slowly from certain plastic elbows and tees used in residential plumbing. Because some states enforce an ultratrace maximum limit for formaldehyde in drinking water (the limit in California, for example, is 30 ppb; that for New Jersey is 0.65 ppb), there is a need for analytical procedures which quantitate this pollutant rapidly with the required sensitivity. A study conducted to determine the presence of formaldehyde in water samples which were drawn from outside mains and from taps in one and two story residences is described.

5604 Other Environmental Pollutant Effects

Refer also to citation(s) 32435, 33226, 33240

33257 (CONF-900724–1) **Unusual formaldehyde-induced hypersensitivity in two schoolgirls.** Gammage, R.B. (Oak Ridge National Lab., TN (USA)); Hanna, W.T.; Painter, P.B. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 5. international conference on indoor air quality and climate; Toronto (Canada); 29 Jul - 3 aug 1990. Order Number DE90009239. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Two schoolgirls developed a syndrome resembling Henoch-Schonlein purpura while attending a recently opened school insulated with urea-formaldehyde foam (UFFI). Skin rashes and swellings were accompanied by bizarre, blue-green discoloration of the skin. Subsequent investigations by county, state and federal authorities, and low measured concentrations of formaldehyde, prompted initial conclusions that in-school formaldehyde exposures were not responsible for the girls' problems. Subsequent controlled exposures to UFFI and formaldehyde while in hospital elicited the whole cascade of symptoms. The chronology of the onset and amplification of systems make it probable that the formaldehyde exposures precipitating the girls' hypersensitivity, occurred in the school. 3 refs.

33258 (PB–90-180704/XAB) **Health-hazard evaluation report HETA 88-229-1985, Ormet Corporation, Hannibal, Ohio.** Moss, C.E.; Stephenson, R.L. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Sep 1989. 26p. (HETA–88-2291985). Available from NTIS, PC A03/MF A01.

See also PB–90-129057.

An evaluation was made of possible exposures to magnetic fields and optical radiation among potroom workers at the Ormet Corporation (SIC-3334), Hannibal, Ohio. Ormet had a large aluminum reduction facility with six potrooms, each potroom consisting of two buildings, 100 feet long, housing 86 pots for a total of 1032 pots. The maximum levels of far ultraviolet, near ultraviolet, visible, and infrared radiation were nondetectable, 120 microwatts/square centimeter (sq cm), 0.3 candela/sq cm, and 190 milliwatts/sq cm, respectively. Static magnetic field levels were as high as 1600 gauss at the location of the workers. Infrared radiation and static magnetic field levels were found to exceed the recommended guidelines from the American Conference of Governmental Industrial Hygienists of 10 milliwatts/sq cm and 600 gauss, respectively. Workers may be exposed to excessive levels of infrared radiation and static magnetic fields. Metal rod used to break up slag in the pots were affected by the strong magnetic fields, so that it was necessary for workers to exert considerable force to overcome the attraction to metal objects to use the rods; this may present an ergonomic hazard. Specific measures to reduce potentially significant occupational exposures and safety risks at this facility are recommended.

33259 **Extremely low frequency electromagnetic fields: The question of cancer.** Wilson, B.W. (Pacific Northwest Lab., Richland, WA (USA). Chemical Sciences Dept.); Stevens, R.G.; Anderson, L.E. 383p. Battelle Press, Columbus, OH (USA) (1990).

The authors focus on that which seems to be the central scientific issue emerging from current ELF research in epidemiology and in the laboratory; namely, can ELF electromagnetic fields interact with biological systems in such a way as to increase cancer risk? The authors examine how cancer risk might be related to two reproducible biological effects of ELF exposure: effects on the pineal gland and circadian biology, and effects on calcium homeostasis in cells. Because they are concerned with the possible biological mechanisms of carcinogenesis, epidemiological studies are only briefly reviewed.

33260 **Chronobiological effects of electric fields.** Groh, K.R. (Biological, Environmental and Medical Research Div., Argonne National Lab., Argonne, IL (US)); Readey, M.A.; Ehret, C.F. 47-86 of Extremely low frequency electromagnetic fields: The question of cancer. Wilson, B.W.; Stevens, R.G.; Anderson, L.E. Battelle Press, Columbus, OH (USA) (1990). DOE Contract W-31-109-ENG-38.

The primary biological effects of nonionizing electromagnetic radiation probably do not include direct genetic damage. More subtle and indirect modes of action, which include disruption of chronobiological relationships, however, are almost certainly involved. Disruption of temporal circadian relationships has been shown to have far-reaching biological consequences. Such temporal disruptions can be caused by alterations in environmental cues (light, food, temperature), by social and behavior cues (such as experienced during jet lag and shift work), and by numerous chemicals

and drugs. Nonionizing electromagnetic radiation has been shown to influence entrained circadian rhythms by altering phase relationships of physiological parameters such as body temperature, oxygen consumption, and carbon dioxide production. A behavioral-phase measure, gross animal activity, is also changed by electromagnetic-radiation exposure. The phase shifts of these gross parameters caused by acute electric-field exposure are measures of the disruption occurring in fundamental biochemical and cellular processes. Disruptions of established circadian rhythms are associated with alterations in the cell division cycle, which may lead to mutagenesis and oncogenesis. In entrained, synchronized metabolic and biochemical pathways, the disruptions of cyclic processes affect many biological functions, decreasing the effectiveness of therapeutic drug treatment, producing effective (mood) disorders, decreasing mental and physical well-being, and impairing immunocompetence. This paper discusses electromagnetic exposure and the resultant disruption of chronobiological integrity, environmental factors that provoke growing concern as having potentially significant impacts on human health.

57 HEALTH AND SAFETY

Refer also to citation(s) 32136, 32137, 32138, 32139, 32140, 32141, 32142, 32143, 32144, 32146, 33056, 33120, 33121, 33135, 33234

58 GEOSCIENCES

Refer also to citation(s) 32160, 32168, 32169, 32170, 32172, 32191, 32224, 32236, 32238, 32717, 32842, 33001, 33037, 33039, 33100, 33108, 33316

33261 (LBL–28712) **A comparison of analytical approaches for wellbore heat transmission in layered formations.** Wu, Yu-Shu. Lawrence Berkeley Lab., CA (USA). Aug 1988. 54p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90011222. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report presents an analytical method for determining wellbore heat transmission during liquid or gas flow along the tubing. The mathematical model describes the heat transfer between the flowing fluid in the wellbore and in the surrounding formation as one whole physical system. The transient heat transfer equations in the two regions with coupling at the sandface are solved simultaneously. Non-homogeneous formations are treated which consist of several layers with different physical properties and arbitrary initial temperature distributions in the vertical direction. Closed form analytical solutions are obtained in real space and in Laplace space, which can be used to calculate the temperature distribution along the wellbore and in the formation, and to evaluate heat transfer rate and cumulative heat exchange between wellbore and formation. A more accurate formula is given for the widely-used transient heat conduction function $f(t_D)$ of thermal resistance. 14 refs., 12 figs., 1 tab.

33262 (LBL–28958) **Acoustic and elastic diffraction tomography and its application to fracture detection.** Tura, M.A.C. Lawrence Berkeley Lab., CA (USA). Apr 1990. 182p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90011305. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

The inverse problem of fracture detection is approached using a waveform imaging method. The Born approximation is utilized for the linearization of the nonlinear inverse scattering problem. The inversion is performed using two separate methods, the conventional back propagation method and a quadratic programming method with constraints. Initially, the two-dimensional acoustic problem is discussed and the following developments are treated: estimation of a background velocity to be used in the inversion, sensitivity of the inversion algorithm to velocity and how this can be utilized to reduce unwanted wave modes, effect of the total field on the inversion, incorporation of free-surfaces, inversion with slanted boreholes, and two-and-a-half-dimensional corrections. The theory for the elastic case is developed next. The operators acting on the elastic parameters are discussed and their properties used for the inversion of individual elastic parameters. A method that stabilizes the inverse problem using multi-frequencies and constrained angles is introduced and tested on synthetic data. A fractured medium will in general be transversely isotropic. Therefore, the theory is extended to the transverse isotropy case for SH-waves and elliptical anisotropy for quasi-P waves. Reconstruction of multi-parameters in a transversely isotropic medium is also discussed. 65 refs.

33263 (NAGRA-NTB–86-05) **Exploratory borehole Leuggern: geology: Appendix volume.** Peters, Tj. (Bern Univ., Mineralogisch-petrographisches Inst. (Switzerland)); Meyer, J.; Matter, A.; Blaesi, H.R.; Isenschmid, Ch.; Kleboth, P.; Meyer, Ch. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Mar 1989. 99p. (In German). Available from Nagra, CH-5401 Baden, Switzerland.

Also published as 'Geologischer Bericht Nr. 9 der Landeshydrologie und -geologie'.

This volume contains the experimental data of the exploratory borehole Leuggern the drilling of which is desbribed in the text volume.

33264 (NAGRA-NTB–86-05) **Exploratory borehole Leuggern: geology: Text volume.** Peters, Tj. (Bern Univ., Mineralogisch-petrographisches Inst. (Switzerland)); Meyer, J.; Matter, A.; Blaesi, H.R.; Isenschmid, Ch.; Kleboth, P.; Meyer, Ch. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Mar 1989. 253p. (In German). Available from Nagra, CH-5401 Baden, Switzerland.

Also published as 'Geologischer Bericht Nr. 9 der Landeshydrologie und -geologie'.

The Leuggern borehole was drilled in the Plateau Jura of Canton Aargau. The drill-site lies on land administered by the borough of Leuggern, and is located some 13 km to the north of Brugg. Drilling work lasted from July 9, 1984, until February 10, 1985. Isolated short sections were drilling using a centre-bit, but otherwise a roller-bit was used exclusively and the sedimentary cover and crystalline basement were cored virtually continuously down to the maximum depth of 1688.90 m. The 22.26 m thick sedimentary succession is subdivided into Quarternary, Upper, Middle and Lower Muschelkalk and Buntsandstein. The Upper Muschelkalk includes approximately 10 m of Trigonodus Dolomite in fully dolomitised Plattenkalk-facies. The Lower Muschelkalk is developed in its typical uniform mudmarl facies. The basement lies beneath the Bundsandstein, which rests in sharply discordant contact above the basement. The crystalline basement at Leuggern was overprinted by several post-metamorphic, post-granitic, tectonic-hydrothermal events. Later events are recorded by solution cavities and mineral fracture fillings which grew freely into open fractures. Despite problems with orientation of the core sketches, structural analyses yielded interesting results. The following petrophysical parameters were determined for the various basement lithologies: rock and grain density; total and effective porosity; internal and external specific surface and thermal conductivity. The effect of the hydrothermal alteration on these parameters is generally considerable. The location of water inflow was accomplished by means of 'fluid logging' and core inspection. A total of 35 inflow points were registered, of which 29 were clearly identifiable on the core itself. Four different types of flow systems could be characterised. (author) 22 tabs., 109 refs.

33265 (NAGRA-NTB–86-10) **Exploratory borehole Leuggern: constructional and environmental aspects, drilling technique.** Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Oct 1989. 161p. (In German). Available from Nagra, CH-5401 Baden, Switzerland.

The exploration well at Leuggern was realized as the sixth well within the Nagra Deep Drilling Program in Northern Switzerland. The drilling work was started July 9, 1984. Having reached the final depth of 1688.9 m on February 19, 1985 the test phase was then initiated and completed by May 24, 1985. In summer 1987 the installation of the long-term monitoring system for five zones was executed. The installation was finished on the day of October 2, 1987. The present report presents the drilling activities, civil construction work related to the site and precautions taken to account for environmental protection aspects. A chapter dealing with the

commission representing members of the federal, cantonal and local authorities and reporting is given at the end of this report. (author) 26 tabs.

33266 (NAGRA-NTB–86-19) **Chemistry of waters in the Boettstein, Weiach, Riniken, Schafisheim, Kaisten and Leuggern boreholes: a hydrochemically consistent data set.** Pearson, F.J. Jr. (Houston (USA)); Lolcama, J.L.; Scholtis, A. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Jun 1989. 151p. Available from Nagra, CH-5401 Baden, Switzerland.

Chemical analyses were made on water samples taken from many intervals of the first six Nagra deep boreholes. Wittwer gives complete results of these analyses, evaluates their purity, and where possible, corrects them for contamination. This report evaluates the geochemical consistency of these analyses with formations from which the samples were extracted. Most samples appear to have lost CO_2 during collection, leading to calculated oversaturation with respect to calcite. Such samples were adjusted to calcite saturation, and the pH values, concentrations of carbonate species, and other saturation indices are given at that state. Saturation indices were also calculated for the minerals dolomite, anhydrite, celestite, barite, fluorite, and the silica minerals quartz and chalcedony, all of which are present in one or more of the rock type samples. With a few exceptions there is consistency between the calculated saturation indices and the presence of the respective minerals. This indicates that both the analytical data on the components of the minerals and the mineral properties included in the thermochemical data base are reliable. Oxidation potentials were calculated from the platinum electrode potential and from analyzed concentrations of members of several redox couples. pE values based on the arsenic couple and the assumption of uraninite saturation tend to be similar. The platinum electrode potential measured in some samples is also similar. A thermochemical data base for aqueous species and minerals was developed to support the geochemical modeling performed for this report. This data base and the sources of the data chosen are given in an appendix. (author) 22 refs., 23 tabs.

33267 (NAGRA-NTB–87-14) **Grimsel test site: geology.** Keusen, H.R. (Geotest, Zollikofen (Switzerland)); Ganguin, J.; Schuler, P.; Buletti, M. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Feb 1989. 167p. (In German). Available from Nagra, CH-5401 Baden, Switzerland.

Concepts which foresee the disposal of radioactive waste in geological formations lay great weight on acquiring knowledge of the proposed host rock and the surrounding rock strata. For this reason, Nagra has, since May 1984, been operating the Grimsel Test Site which is situated at a depth of 450 m in the crystalline formation of the Aar Massif. The general objectives of the research being carried out in this system of test tunnels include, in particular, the build-up of know-how in planning, performing and interpreting underground experiments in different scientific fields and the acquisition of practical experience in developing, testing and applying test equipment and measuring techniques. The Test Site (GTS) is operated by Nagra. On the basis of a German-Swiss cooperation agreement, the various experiments are carried out by Nagra, the Federal Institute for Geoscience and Natural Resources (BGR) and the Research Centre for Environmental Sciences (GSF); the latter two bodies are supported in this venture by the German Federal Ministry for Research and Technology (BMFT). NTB-47 gives an overview of the GTS and a review of the status of the investigation programme as at August 1985. (author) 40 figs., 22 tabs., 53 refs.

33268 (NAGRA-NTB–87-17) **Interpretation of hydraulic testing in the sediments of the Riniken borehole.** Belanger, D.W. (Intera Technologies, Inc., Austin, TX (USA)); Cauffman, T.L.; Lolcama, J.L.; Longsine, D.E.; Pickens, J.F. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Jan 1989. 143p. Available from Nagra, CH-5401 Baden, Switzerland.

The results of the hydraulic testing program in the Riniken borehole are presented as a summary of interpreted hydraulic conductivity, formation pressure, and equivalent freshwater head. Hydraulic tests were completed in 22 separate intervals in the Permian, Triassic and Jurassic sediments intersected by the borehole. Riniken was drilled to 1800.5 m apparent depth and tests were conducted in either single packer configuration, double packer configuration, or open borehole and the test interpretation approach is also presented along with estimates of equipment-related uncertainty on equivalent freshwater head values. Testing was completed using either slug injection or withdrawal, pulse injection or withdrawal, drill-stem, or continuous pumping methods. Analytical solution and graphical (Horner) techniques were utilized for determining hydraulic conductivities of the tested formations. Where the test results were influenced significantly by a pressure disturbance around the borehole and/or thermal effects in the test interval, the INTERA Graph Theoretic Field Model (GTFM) was used to simulate the measured pressure responses. Undisturbed fluid pressures in the tested formations were estimated for 6 test intervals by simulating the measured recovery to a static pressure or through the Horner method of drill-stem test analysis. Two additional formation pressures were determined from static water levels after testing in the open borehole. The equivalent freshwater heads, determined from formation pressure at the test interval or formation center, ranged from 460.4 m ASL at 515 m below ground surface in the Schilfsandstein to 360.6 m ASL at 1100 m below ground surface in the Permian. Ground surface datum at Riniken is 385.07 m. (author) 35 figs., 8 tabs., 36 refs.

33269 (NAGRA-NTB–87-19) **Interpretation of hydraulic testing in crystalline rock at the Leuggern borehole.** Belanger, D.W. (Intera Technologies, Inc., Austin, TX (USA)); Freeze, G.A.; Lolcama, J.L.; Pickens, J.F. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Mar 1989. 312p. Available from Nagra, CH-5401 Baden, Switzerland.

This report presents the results of hydrogeologic interpretations of all analyzable single packer, double packer, and H-log tests conducted in the crystalline rock in the Leuggern borehole. Testing of the Muschelkalk at 74.95 to 117.85 m depth is discussed by Schmassmann (1985). Test 217.9S, which is discussed in this report, contains 14.51 m of Buntsandstein and 4.79 m into the top of the crystalline. A discussion of the testing and interpretation methods is presented. Data analysis was performed using borehole pressure history and thermally-induced pressure effects to be incorporated into the simulations. Formatio pressure (and corresponding equivalent freshwater heads) were determined for 12 test intervals where testing was performed soon after drilling and the formation had an intermediate to high hydraulic conductivity. The calculated equivalent freshwater heads were between 363 m ASL near the top of the crystalline to about 356 m ASL at the bottom of the borehole. Hydraulic conductivities were estimated for 81 intervals, covering the entire crystalline rock portion of the Leuggern borehole. Interpreted hydraulic conductivities ranged from 2.0E-14 to 1.0E-6 ms^{-1}. A base case specific storage of 2.2E-7 m^{-1} was estimated for the crystalline rock. A sensitivity analysis was conducted for some tests to determine the uncertainty in the best estimate of hydraulic conductivity related to the choice of specific storage. In these cases, specific storage was varied by 1 to 2 orders of magnitude from the base case value. The measured temperature in the borehole ranged from about 19°C at the top of the crystalline rock to about 66°C at the bottom of the borehole. The temperature increases approximately linearly with depth at a gradient of approximately 3.4°C/100 m. (author) 17 figs., 7 tabs., 40 refs.

33270 (NAGRA-NTB–87-20) **Interpretation of hydraulic testing at the Weiach borehole.** Butler, G.A. (Intera Technologies, Inc., Austin, TX (USA)); Cauffman, T.L.; Lolcama, J.L.; Longsine, D.E.; Mc Neish, J.A. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Aug 1989. 268p. Available from Nagra, CH-5401 Baden, Switzerland.

This report presents the results of hydrogeologic interpretations of all analyzable single packer, double packer, and H-log tests conducted in the Weiach borehole. Ten of the 37 technically successful tests were conducted using a single packer configuration. One test of the Upper Muschelkalk was configured using temporary casing with an external casing packer to conduct a drawdown-recovery test in the isolated zone. Twenty-six intervals were tested using a

double packer configuration. Nineteen of these intervals were tested using a hydraulic test tool (HTT). Seven of these intervals were tested using a drill-stem test (DST) tool and drill-stem test methods and one test was completed with a DST tool used to isolate the test interval for a pumping sequence. Three H-log tests were completed near the bottom of the borehole with the HTT and double packer configuration. All the tests were completed with one or more of the following test methodologies at each test interval: slug tests, pulse tests, drill-stem tests (DST) and pumping tests. The tests discussed in this report cover the section of the borehole from apparent depth (along the borehole length) of 188.0 m to the bottom of the borehole at 2482.2 m. The testing occurred within the Malm, Dogger, Lias, Keuper, Muschelkalk, Buntsandstein, Perm, Karbon, and Crystalline Groups. A discussion of the testing and interpretation methods is presented. Data analysis was performed using the INTERA Graph Theoretic Field Model (GTFM) which permits borehole pressure history and thermally-induced pressure effects to be incorporated into the simulatons, and Hornergraphical techniques. (author) 32 figs., 10 tabs., 37 refs.

33271 (NAGRA-NTB–88-03) **Oberbauenstock (OBS) 1987: results of the hydrogeological testing program OBS-1.** Kennedy, K.G. (Gartner Lee, Geneva (Switzerland)); Davidson, L.M. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Feb 1989. 460p. Available from Nagra, CH-5401 Baden, Switzerland.

In order to determine the hydrogeological characteristics of the rock mass at the potential repository site for low and medium level radioactive waste at Oberbauenstock, a total of 30 hydraulic packer tests were conducted in 1987 in the three boreholes drilled. This report contains technical information on testing activities as well as the results of the first stage of analyses done in the field. The first part emphasizes information on the testing methodology and on the equipment used. The methods for test analysis are described and illustrated by means of three selected test examples. In one chapter special tests dedicated to the investigation of system's compliance effects are described. The results of the tests done are contained in the last part of the report. The test is supplemented by a number of figures and tables. In addition, test data and results for all individual tests performed are compiled in the appendix. (author) 145 figs., 27 tabs., 11 refs.

33272 (NAGRA-NTB–88-08) **Exploratory borehole Weiach: investigation report: Appendix volume.** Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Aug 1989. 115p. (In German). Available from Nagra, CH-5401 Baden, Switzerland.

In 1980, Nagra (National Cooperative for the Storage of Radioactive Waste) carried out an extensive geological investigation programme covering an area of some 1'200 km^2 in Northern Switzerland. The aim of the programme was to obtain the geological information necessary for assessing the suitability of the crystalline basement as a disposal medium for high-level radioactive waste. The wide range of investigations carried out can be divided into a deep drilling programme, geophysical reconnaissance of the regional petrophysical and structural conditions, a hydrogeological programme for investigation of water flowpaths deep in the bedrock and a neotectonic programme for identification of active crustal movements in the area. This report is a summary of the most important results obtained during the course of the programme. Similar information and datasets are presented for each of the boreholes (Boettstein, Weiach, Leuggern, Schafisheim, Kaisten and Siblingen) in a series of investigation reports, thus allowing intercomparisons to be made between the different sets of results. Conclusions to be drawn from the data will be reserved for a final synthesis report. Detailed reporting of the individual investigations is provided in Nagra's series of Technical Reports (see NTB-list at the end of this report). (author) 76 figs., 23 tabs.

33273 (NAGRA-NTB–88-08) **Exploratory borehole Weiach: investigation report: Text volume.** Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Aug 1989. 232p. (In German). Available from Nagra, CH-5401 Baden, Switzerland.

In 1980, Nagra (National Cooperative for the Storage of Radioactive Waste) carried out an extensive geological investigation programme covering an area of some 1'200 km^2 in Northern Switzerland. The aim of the programme was to obtain the geological information necessary for assessing the suitability of the crystalline basement as a disposal medium for high-level radioactive waste. The wide range of investigations carried out can be divided into a deep drilling programme, geophysical reconnaissance of the regional petrophysical and structural conditions, a hydrogeological programme for investigation of water flowpaths deep in the bedrock and a neotectonic programme for identification of active crustal movements in the area. This report is a summary of the most important results obtained during the course of the programme. Similar information and datasets are presented for each of the boreholes (Boettstein, Weiach, Leuggern, Schafisheim, Kaisten and Siblingen) in a series of investigation reports, thus allowing intercomparisons to be made between the different sets of results. Conclusions to be drawn from the data will be reserved for a final synthesis report. Detailed reporting of the individual investigations is provided in Nagra's series of Technical Reports (see NTB-list at the end of this report). (author) 3 figs., 9 tabs., 191 refs.

33274 (NAGRA-NTB–88-39) **Rock stress investigations.** Pahl, A. (Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hannover (Germany, F.R.)); Heusermann, St.; Braeuer, V.; Gloeggler, W. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Apr 1989. 154p. (In German). Available from Nagra, CH-5401 Baden, Switzerland.

On the research project 'Rock Stress Mesurements' the BGR has developed and tested several methods for use in boreholes at a depth of 200 m. Indirect stress measurements using overcoring methods with BGR-probes and CSIR-triaxial cells as well as direct stress measurements using the hydraulic-fracturing method were made. To determine in-situ rock deformation behavior borehole deformation tests, using a BGR-dilatometer, were performed. Two types of the BGR-probe were applied: a four-component-probe to determine horizontal stresses and a five-component-probe to determine a quasi three-dimensional stress field. The first time a computer for data processing was installed in the borehole together with the BGR-probe. Laboratory tests on low cylinders were made to study the stress-deformation behavior. To validate and to interprete the measurement results some test methods were modelled using the finite-element method. The dilatometer-tests yielded high values of Young's modulus, whereas laboratory tests showed lower values with a distinct deformation anisotropy. Stress measurements with the BGR-probe yielded horizontal stresses being higher than the theoretical overburden pressure. These results are comparable to the results of the hydraulic fracturing tests, whereas stresses obtained with CSIR-triaxial cells are lower. The detailed geological mapping of the borehole indicated relationships between stress and geology. With regard to borehole depth different zones of rock structure joint frequency, joint orientation, and orientation of microfissures as well as stress magnitude, stress direction, and degree of deformation anisotropy could be distinguished. (author) 4 tabs., 76 figs., 31 refs.

33275 (NAGRA-NTB–89-16) **Hydrologic modelling of the migration site at the Grimsel test site - the steady state.** Herzog, F. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Jul 1989. 40p. Available from Nagra, CH-5401 Baden, Switzerland.

Tracer migration experiments are in progress at the Grimsel Test Site (GTS) in order to test radionuclide transport models and to develop appropriate experimental techniques. In order to assist design and to interpret field tracer tests the knowledge of the hydrology of the site is essential. This report describes the hydraulic modelling efforts with the following objectives: (1) to interpret experimental findings, (2) to provide input, such as flowpaths and flow velocities, for transport modelling, (3) to assist in the design of the tracer experiments. The model concept is based upon the observations, that the fracture, where the migration experiments will take place, is relatively planar, has an average aperture of a few millimeters and is filled with a clayish material: The migration fracture is modelled as a two-dimensional, isotropic, heterogeneous equivalent porous medium. To allow for a sufficiently detailed model a hierarchical approach was followed where the boundaries for the 'local' model,

i.e. the model in the vicinity of the migration site, were taken by first solving a larger 'regional' model with coarser discretization. Transmissivity values as extracted from single borehole tests were used for definition of the heterogeneous transmissivity field in the model calculations. Model results for hydrostatic pressures and discharge rates compare favourably with experimental data, even-though some problems remain to be resolved. Calculations for dipole arrangements have been performed; they turned out to be useful tools for deciding on injection- and withdrawal rates to be applied in the migration experiments as well as for qualitatively estimating tracer recovery rates. (author) 20 figs., 10 tabs., 11 refs.

33276 (NAGRA-NTB–89-25) **Identification of tectonic disturbed zones in 2 soil gas profiles from Northern Switzerland.** Ammann, M. (Geologiebuero Dr.J.F.Schneider, Baden (Switzerland)); Schenker, F. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Dec 1989. 68p. (In German). Available from Nagra, CH-5401 Baden, Switzerland.

In the Tabular Jura east of Basel, a field campaign using two soil gas profiles each 1.3 km long was carried out to investigate the possibility of geochemical identification of disturbed zones using gases in the soil. The aim was to clarify to what extent multicomponent gas analyses along measurement profiles could be used for rapid identification of disturbed zones in the field. The exercise was also intended to provide relevant experience in approaching similar problems and to allow optimisation of test procedures. The report explains the principle of the field experiment and the measurement techniques and equipment used. The results are presented, together with a discussion and a cross-comparison with the literature data. The soil gas profiles are at right angles to the Rheinfelden fault and to the Zeiningen disturbed zone. There are no geomorphological indications at the earth's surface of recent movements associated with these two zones. The gas samples were taken using a push-in probe. The gas investigations involved determining concentration so the following components: hydrocarbons C_1 to C_5, CO_2, He, H_2, N_2, and O_2. The measurements were made using two gas chromatographs in a simple field laboratory. The radon content was also determined along the two profiles using α-cups consisting of plastic films which register the α-radiation over a period of several weeks. The investigation show that the most important known disturbed zones can be charted well using the selected procedure. The presumed existence of some disturbed zones could be confirmed and others were discovered for the first time. (author) 12 figs., 2 tabs., 66 refs.

33277 (SLAC–358) **SLAC [Stanford Linear Accelerator Center] site geology, ground motion and some effects of the October 17, 1989 earthquake.** Fischer, G.E. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Dec 1989. 73p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. Order Number DE90010334. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

An attempt is made to correlate ground motions resulting from the October 17, 1989 earthquake with the geologic features of the SLAC site. Recent deformations of the linac are also related to slow motions observed over the past 20 years. Measured characteristics of the earthquake are listed. Some effects on machine components and detectors are noted. Some recommendations regarding instrument site are made. In carrying out this work it was necessary to find and review many of the original records which describe the site and which are still available today. Since only a portion of this material can be found in the published literature, a listing and location file of some of the relevant material is provided. 36 refs., 30 figs.

33278 (USGS/MAP/I–2047) **Geologic map of the surficial deposits of the Yucca Flat area, Nye County, Nevada.** Swadley, W.C.; Hoover, D.L. Geological Survey, Denver, CO (USA). 1990. 20p. Sponsored by U.S. Geological Survey. DOE Contract AI08-86NV10583. Available from OSTI; USGS, Map Distribution, Box 25286, Federal Center, Denver, CO 80225.

Short communication. 17 refs. NEVADA/geologic surveys; GEOLOGIC DEPOSITS/maps; NEVADA; ALLUVIAL DEPOSITS; MAPS; QUATERNARY PERIOD; PLEISTOCENE EPOCH; PLIOCENE EPOCH; TERTIARY PERIOD; CRETACEOUS PERIOD; PLUTONIC ROCKS; SEDIMENTARY ROCKS; PERMIAN PERIOD; GEOLOGIC FAULTS

33279 Obsidian hydration dating: Field, laboratory, and modeling results. McGrail, B.P. (Pacific Northwest Lab., Richland, WA (US)); Pederson, L.R.; Strachan, D.M.; Ewing, R.C.; Cordell, L.S. 263-270 of Materials issues in art and archaeology. Sayre, E.V.; Vandiver, P.; Sruzik, J.; Stevenson, C. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804301–: Materials issues in art and archaeology, Reno, NV (USA), 6-8 Apr 1988).

Hydration rind thicknesses found on obsidian artifacts provide one means of estimating the age of an archaeological site. The model used in the method usually assumes a diffusion-controlled reaction of the glass with water. However, results using this model are not always in agreement with other dating methods. Observations of secondary mineral formation on glasses in contact with water vapor suggests that other rate-controlling mechanisms may be operative. In this paper, the authors apply the glass dissolution code GLASSOL, coupled with the geochemical code PHREEQE to model the reaction of Glass Mountain obsidian in water. The results show the importance of accounting for the effects of solution chemistry on the time-dependence of the hydration reaction.

33280 Identification of oscillations in Ross Sea current data. Grumbine, R.W. (Univ. of Chicago, IL (USA)). *Antarctic Journal of the United States (USA),* 22(5): 110-111 (1987).

As part of the Pelagic Ross Ice Shelf Measurement project, 29 current meters were deployed in the Ross Sea near the ice-shelf edge during the 1983 and 1984 field seasons. The data from these meters give current speed and direction every hour for over a year in most locations. These data should reveal the characteristics of Ross Sea ocean circulation and indicate which processes are most important in ventilating the cavity below the Ross Ice Shelf. One way to analyze these data is to identify periodicity in the currents and thereby to obtain a characteristic fingerprint of ocean dynamics. If the periods in the currents are found to be the same as tidal or season, for example, then the currents are probably caused by tidal or seasonal forcing. To identify such periodicity, a method is needed to discriminate between natural periodicities and apparent periodicities caused by measurement error and random fluctuations. The author used the deviation of current amplitude from the estimated trend to judge the significance of the period tested. He also required that a given periodicity be considered significant on several (at least three) of the current meters before concluding that it was probably physical. Although this method for identifying periods was developed for velocity analysis, it will work for other times series, such as temperature. Results are given.

33281 Trace fossils and bioturbation in peritidal facies of the Potsdam-Theresa Formations (Cambrian-Ordovician), Northwest Adirondacks. Bjerstedt, T.W. (Department of Energy, Las Vegas, NV (USA)); Erickson, J.M. *Palaois (USA),* 4(3): 203-224 (Jun 1989).

The Cambrian-Ordovician Potsdam Sandstone, Theresa Formation, and Canadian correlatives in the St. Lawrence Lowlands preserve tide-dominated facies during the basal Cambrian transgression. Low intertidal sand flats in the upper Potsdam contain a Skolithos Ichnofacies dominated by Diplocraterion parallelum in clean, herringbone cross-bedded sandstones indicative of high tidal current energy. Wind-wave-driven longshore and tidal currents along a macrotidal coastline were funneled northeast-southwest by Precambrian topographic relief of up to 65 m. This relief is now expressed as the Thousand Islands of New York and Canada. The conformably overlying Theresa Formation preserves a shoaling-upward sequence of mixed clastic-carbonate facies. Shallow subtidal and peritidal facies contain a mixed Skolithos-Cruziana Ichnofacies in sharply alternating lithofacies consisting of gray, intensely bioturbated, poorly sorted calcareous sandstone, and meter-thick, white cross-bedded sandstone. The parallelism between ichnofacies and lithofacies indicates that environmental energy level and persistence rather than water depth controlled trace fossil distribution. Bioturbated sandstones contain a Cruziana ichnofacies of abundant deposit feeders including: Fustiglyphus?, Gyrochorte?, Neonereites uniserialis?, Phycodes flabellum, Planolites beverlyensis, Rosselia socialis, and Teichichnus. Suspension

feeders are represented by D. habichi, D. parallelum, Skolithos, Monocraterion, and possibly Palaeophycus tubularis. Scavenging or deposit-feeding arthropods are represented by rare Cruziana? furrows. Cross-bedded sandstones contain a Skolithos Ichnofacies of shallow Skolithos and Monocraterion burrows, and an undescribed large epistratal eurypterid(?) trail.

33282 Paleotectonic significance of the quartzite of the Sauratown Mountains window, North Carolina. Walker, D. (Univ. of Tennessee, Knoxville (USA)); Driese, S.G.; Hatcher, R.D. Jr. *Geology (USA)*, 17(10): 913-917 (Oct 1989). DOE Contract AC05-84OR21400.

Recent mapping within the metamorphic core of the southern Appalachians has led to the identification of several internal basement massifs interpreted to be windows that expose parautochthonous basement beneath the main thrust sheet. One such internal massif is exposed within the Inner Piedmont of North Carolina by the Sauratown Mountain window and is overlain by a cover sequence of arkose, schist, and quartzite. Detailed examination of the primary cross-stratification types preserved within the quartzite at Pilot Mountain indicates that deposition took place in several marine environments ranging from foreshore to inner shelf. Deposits of similar origin within the Early Cambrian North American passive-margin sediments appear to thin west to east, from 80 m at the Chilhowee Group type locality at Chilhowee Mountain (300 km west-southwest of Pilot Mountain) to 40 m within the Unaka belt (150 km west of Pilot Mountain). The quartzite at Pilot Mountain is more than 45 m thick and therefore does not appear to represent a distal part of this passive-margin sequence. Alternatively, two paleotectonic interpretations seem plausible: (1) quartzites of the Sauratown Mountains window, North Carolina, represent Late Proterozoic (Tallulah Falls-Ashe Formation equivalent) deposition along a sea-floor high associated with the rifted basement terrane during the rift phase prior to the opening of Iapetus; or (2) quartzites of the Sauratown Mountains window, North Carolina, represent latest Proterozoic to Early Cambrian (Chilhowee Group time equivalent) deposition on an isolated, rifted continental fragment during the drift phase of the North American-Iapetus margin evolution.

33283 Cordierite-spinel troctolite, a new magnesium-rich lithology from the lunar highlands. Marvin, U.B. (Harvard-Smithsonian Center for Astrophysics, Cambridge, MA (USA)); Carey, J.W.; Lindstrom, M.M. *Science (Washington, D.C.) (USA)*, 243(4893): 925-928 (17 Feb 1989). DOE Contract FG02-87ER13799.

A clast of spinel troctolite containing 8% cordierite ($Mg_2Al_4Si_5O_{18}$) has been identified among the constituents of Apollo 15 regolith breccia 15295. The cordierite and associated anorthite, forsteritic olivine, and pleonaste spinel represent a new, Mg-rich lunar highlands lithology that formed by metamorphism of an igneous spinel cumulate. The cordierite-forsterite pair in the assemblage is stable at a maximum pressure of 2.5 kilobars, equivalent to a depth of 50 kilometers, or 10 kilometers above the lunar crust-mantle boundary. The occurrence of the clast indicates that spinel cumulates are a more important constituent of the lower lunar crust than has been recognized. The rarity of cordierite-spinel troctolite among lunar rock samples suggests that it is excavated only by large impact events, such as the one that formed the adjacent Imbrium Basin. 15 refs., 2 figs., 4 tabs.

64 PHYSICS I

6401 Astrophysics and Cosmology

Refer also to citation(s) 33511, 33518, 33521, 33758

33284 (CBPF-NF–025/89) **Viscous causal cosmologies.** Novello, M. (Universidade Federal, Rio de Janeiro, RJ (Brazil)); Salim, J.M.; Torres, J.; Oliveira, H.P. de. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 23p. Order Number DE90627487. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A set of spatially homogeneous and isotropic cosmological geometries generated by a class of non-perfect is investigated fluids. The irreversibility if this system is studied in the context of causal thermodynamics which provides a useful mechanism to conform to the non-violation of the causal principle. (author).

33285 (FERMILAB-PUB–89/223-A) **False vacuum decay in Jordan-Brans-Dicke cosmologies.** Holman, R. (Carnegie-Mellon Univ., Pittsburgh, PA (USA). Dept. of Physics); Wang, Yun; Kolb, E.W.; Vadas, S.L.; Weinberg, E.J. Fermi National Accelerator Lab., Batavia, IL (USA). Dec 1989. 11p. Sponsored by U.S. DOE Energy Research; National Aeronautics and Space Administration. DOE Contract AC02-76CH03000;AC02-76ER03066;AC02-76ER02271. Grant NAGW-1340. (CMU-HEP–89-24;CU-TP–453). Order Number DE90011125. Available from NTIS, PC A03/MF A01; OSTI; INIS.

We examine the bubble nucleation rate in a first-order phase transition taking place in a background Jordan-Brans-Dicke cosmology. We compute the leading order terms in the nucleation rate when the Jordan-Brans-Dicke field is large (i.e., late times) by means of a Weyl rescaling of the fields in the theory. We find that despite the fact that the Jordan-Brans-Dicke field (hence the effective gravitational constant) has a time dependence in the false vacuum, at late times the nucleation rate is time independent. 21 refs.

33286 (FERMILAB-PUB–90/44-A) **Gravitational couplings of the inflaton in extended inflation.** Holman, R. (Carnegie-Mellon Univ., Pittsburgh, PA (USA). Dept. of Physics); Wang, Yun; Kolb, E.W. Fermi National Accelerator Lab., Batavia, IL (USA). Feb 1990. 9p. Sponsored by U.S. DOE Energy Research; National Aeronautics and Space Administration. DOE Contract AC02-76CH03000;AC02-76ER03066. Grant NAGW-1340. (CMU-HEP–90-03). Order Number DE90011124. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We discuss a new extended inflationary scenario evading the difficulties of the original model. Our model can thermalize the energy in the bubble walls by the necessary epoch, and establish a Robertson-Walker frame in the bubble clusters. The essential new ingredient in our model is the observation that the coupling of inflaton to the Jordan-Brans-Dicke field is expected to be different from that of visible matter. 13 refs., 1 fig.

33287 (FERMILAB-PUB–90/47-A) **Stability of compactification during inflation.** Amendola, L. (Osservatorio Astronomico, Rome (Italy)); Litterio, M.; Occhionero, F.; Kolb, E.W. Fermi National Accelerator Lab., Batavia, IL (USA). Mar 1990. 21p. Sponsored by U.S. DOE Energy Research; National Aeronautics and Space Administration. DOE Contract AC02-76CH03000. Grant NAGW-1340. Order Number DE90011129. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The possibility that inflation may trigger an instability in compactification of extra spatial dimensions is considered. In old, new, or extended inflation, the false vacuum energy results in a semiclassical instability in which the scalar field representing the radius of the extra dimensions may tunnel through a potential barrier leading to an expansion of the internal space. In chaotic inflation, if the initial value of the scalar field responsible for inflation is large enough, the internal space becomes classically unstable to ever increasing expansion. Restrictions on inflationary models necessary to keep the extra dimensions small are discussed. 15 refs., 5 figs.

33288 (FERMILAB-PUB–90/52-A) **Soft inflation.** Berkin, A.L. (Waseda Univ., Tokyo (Japan). Dept. of Physics); Maeda, Kei-ichi; Yokoyama, Jun'ichi. Fermi National Accelerator Lab., Batavia, IL (USA). Apr 1990. 12p. Sponsored by U.S. DOE Energy Research; National Aeronautics and Space Administration. DOE Contract AC02-76CH03000. Grant NAGW-1340;Grant-In-Aid 01795079. (UTAP–107/90). Order Number DE90011127. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We study the cosmology resulting from two coupled scalar fields, one which is either a new inflation or chaotic type inflation and the other which has an exponentially decaying potential. Such potential may appear in the conformally transformed frame of generalized Einstien theories like the Jordan-Brans-Dicke theory. The constraints necessary for successful inflation are examined. We find conventional GUT models such as SU(5) are compatible with new inflation, while restrictions on the self-coupling constant are significantly loosened for chaotic inflation. 20 refs., 1 fig.

33289 (FERMILAB-PUB–90/64-A) **Gravitational effects of global textures.** Noetzold, D. (Chicago Univ., IL (USA). Astronomy and Astrophysics Center). Fermi National Accelerator Lab., Batavia, IL (USA). Mar 1990. 9p. Sponsored by National Aeronautics and Space Administration; National Science Foundation. DOE Contract AC02-76CH03000. Contract NASA-NAGW-1321;Contract NASA-NAGW-1340;Contract AST88-2 Order Number DE90011130. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A solution for the dynamics of global textures is obtained. Their gravitational field during the collapse and the subsequent evolution is found to be given solely by a space-time dependent "deficit solid angle." The frequency shift of photons traversing this gravitational field is calculated. The space-time dependent texture metric locally contracts the volume of three-space and thereby induces overdensities in homogeneous matter distributions. There are no gravitational forces unless matter has a nonzero angular momentum with respect to the texture origin which would be the case for moving textures.

33290 (FERMILAB-PUB–90/69-A) **Ultrahigh-energy particle flux from cosmic strings.** Bhattacharjee, P. (Chicago Univ., IL (USA). Enrico Fermi Inst.). Fermi National Accelerator Lab., Batavia, IL (USA). Apr 1990. 13p. Sponsored by U.S. DOE Energy Research; National Aeronautics and Space Administration; National Science Foundation. DOE Contract AC02-76CH03000. Grant NSF 87-15412;NAGW-1340. Order Number DE90011128. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We estimate the expected flux of ultrahigh-energy ($> 10^{19}$eV) protons in the present epoch due to a process which involves collapse or multiple self-intersections of a special class of closed cosmic string loops in the universe. We compare this flux with the observed flux of ultrahigh-energy cosmic rays, and discuss the implications. 19 refs., 1 fig.

33291 (FNAL/Pub–90/56-A) **Topological defects in extended inflation.** Copeland, E.J. (Sussex Univ., Brighton (UK). Dept. of Physics); Kolb, E.W.; Liddle, A.R. Fermi National Accelerator Lab., Batavia, IL (USA). Apr 1990. 10p. Sponsored by U.S. DOE Energy Research; National Aeronautics and Space Administration. DOE Contract AC02-76CH03000. Grant NAGW-1340. Order Number DE90011126. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We consider the production of topological defects, especially cosmic strings, in extended inflation models. In extended inflation, the Universe passes through a first-order phase transition via bubble percolation, which naturally allows defects to form at the end of inflation. The correlation length, which determines the number density of the defects, is related to the mean size of bubbles when they collide. This mechanism allows a natural combination of inflation and large-scale structure via cosmic strings. 18 refs.

33292 (IC–90/15) **Quantifying the FIR interaction enhancement in paired galaxies.** Xu Cong (International Centre for Theoretical Physics, Trieste (Italy)); Sulentic, J.W. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 6p. Order Number DE90627485. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

We studied the "Catalogue of Isolated Pairs of Galaxies in the Northern Hemisphere" by Karachentsev (1972) and a well matched comparison sample taken from the "Catalogue of Isolated Galaxies" by Karachentseva (1973) in order to quantify the enhanced FIR emission properties of interacting galaxies. 8 refs, 6 figs.

33293 (IC–90/18) **Information loss down a black hole.** Lee, S.C. (National Univ. of Singapore (Sinagpore). Dept. of Physics); Shiekh, A.Y. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 5p. Order Number DE90627482. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

It is found that, to an external observer, an object falling into a black hole is lost beyond any return, in a finite amount of time. (author). 3 refs.

33294 (IFT-P–32/89) **A suggestion on the pair QSO triplets 1130+106 {B,A,C}, {x,y,z}.** Fagundes, H. Instituto de Fisica Teorica (IFT), Sao Paulo, SP (Brazil). 1989. 8p. Order Number DE90627486. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The alignment of a pair of QSO triplets discovered by Arp and Hazard are tentatively explained by a combination of (I) Arp's idea of quasar ejection by galaxies; (II) a construction by Narlikar suggesting a common origin for the six images; and (III) a nontrivial topology of cosmic space. (author).

33295 (KEK-PR–89-1, pp. 262-267) **Recent results of JANZOS.** Tanimori, Toru. (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). 1989. (CONF-8810465–: 3. workshop on elementary-particle picture of the universe, Fujiyoshida (Japan), 17-19 Oct 1988). In *Proceedings of the third workshop on elementary-particle picture of the universe.* Order Number DE90741340. Available from NTIS (US Sales Only), PC A13/MF A01.

JANZOS Group (Collaboration of Japan, Australia and New Zealand) has been monitoring the very high energy gamma rays for SN1987A since the end of 1987 at Black Birch Range. The TeV region gamma ray has been measured with Cherenkov mirror telescopes, and the PeV region gamma ray has been measured with shower counter arrays. In the observation with the Cherenkov mirror, the detection area and median energy of the detectable shower are estimated at $7.2 \times 10^9 m^2$ and 75 TeV, respectively. In virtue of this huge detection area, it is possible to get better statistical results for 100 TeV gamma ray flux than with air shower counter arrays. The distribution of observed events studied as a function of right ascension (RA) in the declination strip -69.3 $\pm$ 0.5 deg. There seem to be no significant excess at the position of SN1987A. The observed number of events and the expected number within 1.5deg width around the 1987A position are calculated at ,924 and 922.7, respectively, which correspond to the upper limits to the gamma ray flux, 52 events with 95% confidence level. The upper limit for the gamma ray flux from SN1987A is estimated at $5.1 \times 10^{-14} cm^{-2} s^{-1}$ up to 75 TeV shower at 95% confidence level. This upper limit corresponds to the upper limit for the luminosity of 10^{37}erg s^{-1}. The Vela X-1 is observed with the Cherenkov mirror. The upper limit for gamma ray flux up to 2 TeV is $6.05 \times 10^{-12} cm^{-2} s^{-1}$, and the upper limit for the luminosity is 9.02×10^{34}erg s^{-1}. (N.K.).

33296 (KFKI–1989-49/A) **Mini-inflation prior to the cosmic confinement transition.** Boyko, V.G.; Jenkovszky, L.L.; Kaempfer, B.; Sysoev, V.M. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Sep 1989. 16p. Order Number DE90627488. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The onset of the confinement transition in the early universe is studied within the Friedmann model. Exploiting a bag model equation of state for the deconfined matter, which is generalized to include also metastable states, the possibility of a mini-inflationary epoch is demonstrated. A criterion of metastability is derived to estimate parameters of this mini-inflation. (author) 14 refs.; 3 figs.

33297 (N–90-15859) **Shapes of star-gas waves in spiral galaxies.** Lubow, S.H. Space Telescope Science Inst., Baltimore, MD (USA). Feb 1988. 7p. (NASA-CR–186289;NAS–1.26:186289;PREPRINT-SERIES–240). Available from NTIS, PC A02/MF A01.

Density-wave profile shapes are influenced by several effects. By solving viscous fluid equations, the nonlinear effects of the gas and its gravitational interaction with the stars can be analyzed. The stars are treated through a linear theory developed by Lin and coworkers. Short wavelength gravitational forces are important in determining the gas density profile shape. With the inclusion of disk finite thickness effects, the gas gravitational field remains important, but is significantly reduced at short wavelengths. Softening of the gas equation of state results in an enhanced response and a smoothing of the gas density profile. A Newtonian stress relation is marginally acceptable for HI gas clouds, but not acceptable for giant molecular clouds.

33298 (N–90-15860) **The disk-halo connection and the nature of the interstellar medium.** Norman, C.A.; Ikeuchi, S. Space Telescope Science Inst., Baltimore, MD (USA).

Jan 1988. 8p. (NASA-CR–186286;NAS–1.26:186286;PREPRINT-SERIES–232). Available from NTIS, PC A02/MF A01.

Some results on the nature of the interstellar medium that are specifically concerned with the disk-halo interaction are discussed. Over the last five years or so it has become clear that the supernovae rate in our Galaxy is spatially clumped and the consequences of such clumping are superbubbles and supershells fed by tens or hundreds of supernovae per shell. These objects evolve and expand rapidly and soon break out of the disk of the Galaxy, feeding the halo with very significant mass, energy, and momentum. As cooling occurs, gas will rain down onto the disk of the Galaxy completing the cycle. The basic flow of physical quantities from disk to halo and vice versa are discussed. Some of the many implications are noted including aspects of dynamo theory, quasar absorption lines, the theory of galactic coronae, and the nature of the x ray background. The essential difference here with the McKee-Ostriker (1977) theory is that the filling factor of the hot gas in the disk is significantly less than unity.

33299 (N–90-15869) **The age of the galactic disk.** Sandage, A. Space Telescope Science Inst., Baltimore, MD (USA). Jul 1988. 15p. (NASA-CR–186292;PREPRINT-SERIES–288;NAS–1.26:186292;CONF-8805367–: Workshop on the calibration of stellar ages, Middletown, CT (USA), 13-14 May 1988). Available from NTIS, PC A03/MF A01.

The galactic disk is a dissipative structure and must, therefore be younger than the halo if galaxy formation generally proceeds by collapse. Just how much younger the oldest stars in the galactic disk are than the oldest halo stars remains an open question. A fast collapse (on a time scale no longer than the rotation period of the extended protogalaxy) permits an age gap of the order of approximately 10 to the 9th power years. A slow collapse, governed by the cooling rate of the partially pressure supported falling gas that formed into what is now the thick stellar disk, permits a longer age gap, claimed by some to be as long as 6 Gyr. Early methods of age dating the oldest components of the disk contain implicit assumptions concerning the details of the age-metallicity relation for stars in the solar neighborhood. The discovery that this relation for open clusters outside the solar circle is different that in the solar neighborhood (Geisler 1987), complicates the earlier arguments. The oldest stars in the galactic disk are at least as old as NGC 188. The new data by Janes on NGC 6791, shown first at this conference, suggest a disk age of at least 12.5 Gyr, as do data near the main sequence termination point of metal rich, high proper motion stars of low orbital eccentricity. Hence, a case can still be made that the oldest part of the galactic thick disk is similar in age to the halo globular clusters, if their ages are the same as 47 Tuc.

33300 (N–90-15870) **Recent progress in understanding the eruptions of classical novae.** Shara, M.M. Space Telescope Science Inst., Baltimore, MD (USA). Oct 1988. 52p. (NASA-CR–186280;NAS–1.26:186280;PREPRINT-SERIES–314). Available from NTIS, PC A04/MF A01.

Dramatic progress has occurred in the last two decades in understanding the physical processes and events leading up to, and transpiring during the eruption of a classical nova. The mechanism whereby a white dwarf accreting hydrogen-rich matter from a low-mass main-sequence companion produces a nova eruption has been understood since 1970. The mass-transferring binary stellar configuration leads inexorably to thermonuclear runaways detected at distances of megaparsecs. Summarized here are the efforts of many researchers in understanding the physical processes which generate nova eruptions; the effects upon nova eruptions of different binary-system parameters (e.g., chemical composition or mass of the white dwarf, different mass accretion rates); the possible metamorphosis from dwarf to classical novae and back again; and observational diagnostics of novae, including x ray and gamma ray emission, and the characteristics and distributions of novae in globular clusters and in extragalactic systems. While the thermonuclear-runaway model remains the successful cornerstone of nova simulation, it is now clear that a wide variety of physical processes, and three-dimensional hydrodynamic simulations, will be needed to explain the rich spectrum of behavior observed in erupting novae.

33301 (N–90-15871) **The volatile composition of comets.** Weaver, H.A. Space Telescope Science Inst., Baltimore, MD (USA). Nov 1988. 8p. (NASA-CR–186281;NAS–1.26:186281;PREPRINT-SERIES–316). Available from NTIS, PC A02/MF A01.

Comets may be our best probes of the physical and chemical conditions in the outer regions of the solar nebula during that crucial period when the planets formed. The volatile composition of cometary nuclei can be used to decide whether comets are the product of a condensation sequence similar to that invoked to explain the compositions of the planets and asteroids, or if comets are simply agglomerations of interstellar grains which have been insignificantly modified by the events that shaped the other bodies in the solar system. Although cometary nuclei are not generally accessible to observation, observations of cometary comae can illuminate at least some of the mysteries of the nuclei provided one has a detailed knowledge of the excitation conditions in the coma and also has access to basic atomic and molecular data on the many species present in comets. Examined here is the status of our knowledge of the volatile composition of cometary nuclei and how these data are obtained.

33302 (N–90-16442, pp. 237-240) **Stochastic simulation of charged particle transport on the massively parallel processor.** Earl, J.A. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1988. (NASA-TM–101918;NAS–1.15:101918;IEEE-ORDER–892;LC–88-82088;IEEE-CAT 2. symposium on the frontiers of massively parallel computation, Fairfax, VA (USA), 10-12 Oct 1988). In *The 2nd Symposium on the Frontiers of Massively Parallel Computations.* Available from NTIS, PC A99/MF A04.

Computations of cosmic-ray transport based upon finite-difference methods are afflicted by instabilities, inaccuracies, and artifacts. To avoid these problems, researchers developed a Monte Carlo formulation which is closely related not only to the finite-difference formulation, but also to the underlying physics of transport phenomena. Implementations of this approach are currently running on the Massively Parallel Processor at Goddard Space Flight Center, whose enormous computing power overcomes the poor statistical accuracy that usually limits the use of stochastic methods. These simulations have progressed to a stage where they provide a useful and realistic picture of solar energetic particle propagation in interplanetary space.

33303 (N–90-16607) **Workshop on Analysis of Returned Comet Nucleus Samples.** Lunar and Planetary Inst., Houston, TX (USA). 1989. 98p. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). Available from NTIS, PC A05/MF A01.

This volume contains abstracts that were accepted by the Program Committee for presentation at the workshop on the analysis of returned comet nucleus samples held in Milpitas, California, January 16 to 18, 1989. The abstracts deal with the nature of cometary ices, cryogenic handling and sampling equipment, origin and composition of samples, and spectroscopic, thermal and chemical processing methods of cometary nuclei. Laboratory simulation experimental results on dust samples are reported. Some results obtained from Halley's comet are also included. Microanalytic techniques for examining trace elements of cometary particles, synchrotron x ray fluorescence and instrument neutron activation analysis (INAA), are presented.

33304 (N–90-16607, pp. 20-21) **Trace element abundance determinations by Synchrotron X Ray Fluorescence (SXRF) on returned comet nucleus mineral grains.** Flynn, G.J. (Brookhaven National Lab., Upton, NY (USA)); Sutton, S.R. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Trace element analyses were performed on bulk cosmic dust particles by Proton Induced X Ray Emission (PIXE) and Synchrotron X Ray Fluorescence (SXRF). When present at or near chondritic abundances the trace elements K, Ti, Cr, Mn, Cu, Zn, Ga, Ge, Se, and Br are presently detectable by SXRF in particles of 20 micron

diameter. Improvements to the SXRF analysis facility at the National Synchrotron Light Source presently underway should increase the range of detectable elements and permit the analysis of smaller samples. In addition the Advanced Photon Source will be commissioned at Argonne National Laboratory in 1995. This 7 to 8 GeV positron storage ring, specifically designed for high-energy undulator and wiggler insertion devices, will be an ideal source for an x ray microprobe with one micron spatial resolution and better than 100 ppb elemental sensitivity for most elements. Thus trace element analysis of individual micron-sized grains should be possible by the time of the comet nucleus sample return mission.

33305 (N–90-16607, pp. 31) **Role of dust to gas production rate ratio in cometary physics.** Ibadov, S. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

According to results of Earth based observations and in situ measurements cometary nuclei are intensive sources of both the gaseous and the dusty matter. Investigations of the interaction between gas-dust cometary atmospheres and dust grains of the Zodiacal dust cloud reveals the presence of two principally possible mechanisms: meteor-like and explosive-type ones. The meteor-like mechanism is connected with bombardment of zodiacal dust particles by cometary molecules when the temperatures T = 2000 to 3000 K are developed. This mechanism can create over-saturated vapors of refractory elements (Fe, Si, C etc.) in cometary heads. The explosion-type mechanism is connected with high-velocity impacts between cometary and zodiacal dust particles resulting in the generation of high-temperature plasma (T = 10(exp 5) to 10(exp 7) K) and, hence, of x ray radiation and multicharged ions, i.e., with the processes not yet realized in the laboratory conditions.

33306 (N–90-16607, pp. 36-37) **Identification of solar nebula condensates in interplanetary dust particles and unequilibrated ordinary chondrites.** Kloeck, W. (Lockheed Corp., Houston, TX (USA)); Thomas, K.L.; Mckay, D.S. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Orthopyroxene and olivine grains, low in FeO, but containing MnO contents up to 5 wt percent were found in interplanetary dust particles (IDP) collected in the stratosphere. The majority of olivines and pyroxenes in meteorites contain less than 0.5 wt percent MnO. Orthopyroxenes and olivines high in Mn and low in FeO have only been reported from a single coarse grained chondrule rim in the Allende meteorite and from a Tieschitz matrix augite grain. The bulk MnO contents of the extraterrestrial dust particles with high MnO olivines and pyroxenes are close to CI chondrite abundances. High MnO, low FeO olivines and orthopyroxenes were also found in the matrix of Semarkona, an unequilibrated ordinary chondrite. This may indicate a related origin for minerals in extraterrestrial dust particles and in the matrix of unequilibrated ordinary chondrites.

33307 (N–90-16607, pp. 41-42) **Computer simulation of dust grain evolution.** Liffman, K. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

The latest results are reported from a Monte Carlo code that is being developed at NASA Ames. The goal of this program, is to derive from the observed and presumed properties of the interstellar medium (ISM) the following information: (1) the size spectrum of interstellar dust; (2) the chemical structure of interstellar dust; (3) interstellar abundances; and (4) the lifetime of a dust grain in the ISM. Presently this study is restricted to refractory interstellar material, i.e., the formation and destruction of ices are not included in the program. The program is embedded in an analytic solution for the bulk chemical evolution of a two-phase interstellar medium in which stars are born in molecular clouds, but new nucleosynthesis products and stellar return are entered into a complementary intercloud medium. The well-mixed matter of each interstellar phase is repeatedly cycled stochastically through the complementary phase and back. Refractory dust is created by thermal condensation as stellar matter flows away from sites of nucleosynthesis such as novae and supernovae and/or from the matter returned from evolved intermediate stars. The history of each particle is traced by standard Monte Carlo techniques as it is sputtered and fragmented by supernova shock waves in the intercloud medium. It also accretes an amorphous mantle of gaseous refractory atoms when its local medium joins with the molecular cloud medium. Finally it encounters the possibility of astration (destruction by star formation) within the molecular clouds.

33308 (N–90-16607, pp. 52-53) **Evolution of carbonaceous chondrite parent bodies: Insights into cometary nuclei.** McSween, H.Y. Jr. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

It is thought that cometary samples will comprise the most primitive materials that are able to be sampled. Although parent body alteration of such samples would not necessarily detract from scientists' interest in them, the possibility exists that modification processes may have affected cometary nuclei. Inferences about the kinds of modifications that might be encountered can be drawn from data on the evolution of carbonaceous chondrite parent bodies. Observations suggest that, of all the classes of chondrites, these meteorites are most applicable to the study of comets. If the proportion of possible internal heat sources such as Al-26 in cometary materials are similar to those in chondrites, and if the time scale of comet accretion was fast enough to permit incorporation of live radionuclides, comets might have had early thermal histories somewhat like those of carbonaceous chondrite parent bodies.

33309 (N–90-16664) **Accretion shock geometries in the magnetic variables.** Stockman, H.S. Space Telescope Science Inst., Baltimore, MD (USA). Jul 1988. 23p. (NASA-CR–186290;PREPRINT-SERIES–293;NAS–1.26:186290). Available from NTIS, PC A03/MF A01.

The first self consistent shock models for the AM Herculis-type systems successfully identified the dominant physical processes and their signatures. These homogenous shock models predict unpolarized, Rayleigh-Jeans optical spectra with sharp cutoffs and rising polarizations as the shocks become optically thin in the ultraviolet. However, the observed energy distributions are generally flat with intermediate polarizations over a broad optical band. These and other observational evidence support a non-homogenous accretion profile which may extend over a considerable fraction of the stellar surface. Both the fundamental assumptions underlying the canonical 1-D shock model and the extension of this model to inhomogenous accretion shocks were identified, for both radial and linear structures. The observational evidence was also examined for tall shocks and little evidence was found for relative shock heights in excess of h/R(1) greater than or equal to 0.1. For several systems, upper limits to the shock height can be obtained from either x ray or optical data. These lie in the region h/R(1) is approximately 0.01 and are in general agreement with the current physical picture for these systems. The quasi-periodic optical variations observed in several magnetic variables may eventually prove to be a major aid in further understanding their accretion shock geometries.

33310 (N–90-16675) **Neptune's Triton: A moon rich in dry ice and carbon.** Prentice, A.J.R. Jet Propulsion Lab., Pasadena, CA (USA). Aug 1989. 18p. (NASA-CR–186298;NAS–1.26:186298;JPL-Publ–89-37). Available from NTIS, PC A03/MF A01.

The encounter of the spacecraft Voyager 2 with Neptune and its large satellite Triton in August 1989 will provide a crucial test of ideas regarding the origin and chemical composition of the outer solar system. In this pre-encounter publication, the possibility is quantified that Titron is a captured moon which, like Pluto and Charon, originally condensed as a major planetesimal within the

gas ring that was shed by the contracting protosolar cloud at Neptune's orbit. Ideas of supersonic convective turbulence are used to compute the gas pressure, temperature and rat of catalytic synthesis of CH_4, CO_2, and C(s) within the protosolar cloud, assuming that all C is initially present as CO. The calculations lead to a unique composition for Triton, Pluto, Charon: each body consists of, by mass, 18 1/2% solid CO_2 ice, 4 percent graphite, 1/2% CH_4 ice, 29 percent methanated water ice and 48 percent of anhydrous rock. This mix has a density consistent with that of the Pluto-Charon system and yields a predicted mean density for Triton of 2.20 + or - 0.5 g/cu cm, for satellite radius equal to 1,750 km.

33311 (PB–90-156886/XAB) **Solar-Geophysical Data Number 543, November 1989. Part 2 (comprehensive reports). Data for May 1989 and miscellaneous.** Coffey, H.E. National Geophysical Data Center, Boulder, CO (USA). Nov 1989. 136p. (SGD–543-PT-1). Available from NTIS, PC A07/MF A01.

See also PB–90-156878.

Contents: solar flares; solar radio bursts at fixed frequencies; interplanetary solar particles and plasma; solar x-ray radiation from GOES satellite; mass ejections from the sun; active prominences and filaments; solar irradiance.

33312 (PB–90-171661/XAB) **Solar-Geophysical Data Number 544, December 1989. Part 1 (prompt reports). Data for November, October 1989, and late data.** Coffey, H.E. National Geophysical Data Center, Boulder, CO (USA). Dec 1989. 162p. (SGD–544-PT-1). Available from NTIS, PC A08/MF A01.

See also PB–90-156878.

Data for November 1989 – Solar-terrestrial environment, IUWDS alert periods (advance and worldwide), Solar activity indices, Solar flares, Solar radio emission, Stanford mean solar magnetic field; Data for October 1989 – Solar active regions, Sudden ionospheric disturbances, Solar radio spectral observations, Cosmic ray measurements by neutron monitor, Geomagnetic indices; Late data – Cosmic ray measurements by neutron monitor. Huancayo-August 1989, Geomagnetic indices-July, August, September 1989.

33313 (PB–90-182338/XAB) **Solar-Geophysical Data Number 545, January 1990. Part 1 (prompt reports). Data for December, November 1989, and late data.** Coffey, H.E. National Geophysical Data Center, Boulder, CO (USA). Jan 1990. 154p. (SGD–545-PT-1). Available from NTIS, PC A08/MF A01.

See also PB–90-182346, PB–90-171661 and PB–87-233169. Library of Congress catalog card No. 79-640375.

Contents include: detailed index for 1989; data for December 1989–solar-terrestrial environment, IUWDS alert periods (advance and worldwide), solar-activity indices, solar flares, solar radio emission, Stanford mean solar magnetic field; data for November 1989–solar-active regions, sudden ionospheric disturbances, solar radio spectral observations, cosmic-ray measurements by neutron monitor, geomagnetic indices; late data–geomagnetic indices September-October 1989, solar-active regions-carrington rotation 1821 October 1989.

33314 (PB–90-182346/XAB) **Solar-Geophysical Data Number 545, January 1990. Part 2 (comprehensive reports). Data for July 1989 and miscellaneous.** Coffey, H.E. National Geophysical Data Center, Boulder, CO (USA). Jan 1990. 81p. (SGD–545-PT-2). Available from NTIS, PC A05/MF A01.

See also PB–90-182338, PB–90-171679 and PB–87-233169. Library of Congress catalog card No. 79-640375.

Contents include: detailed index for 1989; data for July 1989–solar flares, solar radio bursts at fixed frequencies, solar x-ray radiation from GOES satellite, mass ejections from the sun, active prominences and filaments, solar irradiance.

33315 (RRK–89-28) **Proceedings of workshop on dark matter and the structure of the universe.** Sasaki, Misao (ed.). Hiroshima Univ., Takehara (Japan). Research Inst. for Theoretical Physics. Oct 1989. 218p. (CONF-8901190–: Workshop on dark matter and the structure of the universe, Takehara (Japan), 29 Jan - 1 feb 1989). Order Number DE90791308. Available from NTIS (US Sales Only), PC A10/MF A01.

The workshop on 'Dark matter and the structure of the universe' was held from January 29 to February 1, 1989 at the Research Institute for Theoretical Physics, Hiroshima University. It aimed at clarifying the basic theoretical problems of the dark matter and the structure of the universe, and gaining inspiration on the direction of future research. In the first half of the workshop, the observed data on the large scale structure were critically reviewed, and some new ideas and theoretical frameworks which relate the actual cosmological structure to the observable quantities were presented. In the second half of the workshop, the various possible matters being proposed for the dark matter were examined in the light of both observed (or experimental) data and theoretical predictions. The speakers in the workshop gave well prepared, stimulative talks, and made it possible for the participants to have fruitful and constructive discussions. The workshop was supported partially by the Grant in Aid for Scientific Research, Ministry of Education, and by the Research Institute for Theoretical Physics, Hiroshima University. In this report, eight presentations on observational and theoretical cosmology and ten on dark matter and galaxy formation are collected. (K.I.).

33316 **^{10}Be profiles in lunar surface rock 68815.** Nishiizumi, K. (Dept. of Chemistry, Univ. of California, San Diego, La Jolla, CA (US)); Kohl, C.P.; Arnold, J.R.; Imamura, M.; Nagai, H.; Honda, M.; Kobayashi, K. 79-86 of Proceedings of the eighteenth lunar and planetary science conference. Ryder, G. Cambridge University Press, New York, NY (USA) (1988). Grant NAG-9-33. (CONF-870396–: 18. lunar and planetary science conference, Houston, TX (USA), 16-20 Mar 1987).

This paper reports cosmic-ray-produced ^{10}Be($t_{1/2}$ = 1.6 x 10^6 years) activities measured in 14 carefully ground samples of lunar surface rock 68815. The ^{10}Be profiles from 0 to 4 mm are nearly flat for all three surface angles measured and show a very slight increase with depth from the surface to a depth of 1.5 cm. These depth profiles are in contrast to the SCR (solar cosmic ray)-produced ^{26}Al and ^{53} Mn profiles measured from these same samples. There is no sign of SCR-produced ^{10}Be in this rock. The discrepancy between the data and the Reedy–Arnold theoretical calculation for SCR ^{10}Be production (about 2 atoms/min/kg at the surface) can be explained in two ways: the low-energy cross sections for proton-induced ^{10}Be production from oxygen are lower than those used in the calculations, or compared to the reported fits for ^{26}Al and ^{53}Mn, the solar proton spectral shape is actually softer (exponential rigidity parameter R_0 less than 100 MV), the omnidirectional flux above 10 MeV is higher (more than 70 protons/cm^2 s), and the erosion rate is higher (greater than 1.3 mm/m.y.). ^{10}Be, as a medium- to high-energy product, is a very useful nuclide for determining the SCR spectral shape in the past.

33317 **Cosmology with 100-TeV γ-ray telescopes.** Halzen, F. (Department of Physics, University of Wisconsin, Madison, Wisconsin 53706 (US)); Protheroe, R.J.; Stanev, T.; Vankov, H.P. *Physical Review, D (Particles Fields) (USA),* 41(2): 342-346 (15 Jan 1990). DOE Contract AC02-76ER00881.

We show that the secondary photons which are by-products of the energy loss of extragalactic cosmic rays interacting with the cosmic background have a characteristic energy of 10–100 TeV. For a model where the extragalactic cosmic rays are uniformly distributed in space and in time over the past 10^9 yr the flux of 100-TeV photons is 10^{-5} of the cosmic-ray flux. Such fluxes are attractively close to the resolution of the new generation of γ-ray telescopes and their detection can provide important cosmological information.

33318 **Aspects of the Zel'dovich-Sunyaev mechanism.** Bernstein, J. (Department of Physics, Stevens Institute of Technology, Hoboken, New Jersey 07030 (US)— Department of Physics, The Rockefeller University, New York, New York 10021-5399 (USA)); Dodelson, S. *Physical Review, D (Particles Fields) (USA),* 41(2): 354-373 (15 Jan 1990). DOE Contract FG02-84ER40158.

In this paper we treat aspects of the Compton distortion of the cosmic background radiation (CBR)—what is known as the Zel'dovich-Sunyaev mechanism—which do not appear to have been fully explored in the literature. These include a novel solution

to the so-called Kompaneets equation, a treatment of the simultaneous heating and cooling of free electrons, a discussion of electron-proton "recombination," and a demonstration of the ingredients necessary for efficient energy transfer. These matters are illustrated in a scenario in which the excess CBR energy observed by Matsumoto *et al.* is supplied by a radiatively decaying heavy lepton, so we also provide a careful analytic treatment of the photon spectrum produced by a heavy particle decaying in the early Universe.

33319 Optical detection of the remnant of SN 1980K in NGC 6946. Fesen, R.A. (Colorado Univ., Boulder (USA)); Becker, R.H. *Astrophysical Journal (USA),* 351: 437-442 (Mar 1990).

This paper discusses imaging and spectroscopic data collected with the Cassegrain CCD detector on the 3-m Shane telescope at the Lick Observatory on SN 1980K in NGC 6946 between seven and eight years after maximum. The spectrum of SN 1980K taken in 1987 revealed the presence of faint unresolved H-alpha emission coincident with the supernova's reported position, which remained constant to + or - 0.2 mag between 1987.5 and 1988.6. Guided by the H-alpha interference filter images, a 3-hr-long low-dispersion spectrum was obtained in August 1988, showing several broad emission lines on top of the faint continuum. The detection of optical emission from SN 1980K nearly eight years after the outburst indicates the formation of a young bright supernova remnant and suggests that similarly detectable levels of optical emission may exist from other young historical extragalactic supernovae, particularly those with detectable radio emission. 42 refs.

33320 Molecular equilibrium with condensation. Sharp, C.M. (Los Alamos National Laboratory, NM (USA)); Huebner, W.F. *Astrophysical Journal, Supplement Series (USA),* 72: 417-431 (Feb 1990).

Minimization of the Gibbs energy of formation for species of chemical elements and compounds in their gas and condensed phases determines their relative abundances in a mixture in chemical equilibrium. The procedure is more general and more powerful than previous abundance determinations in multiphase astrophysical mixtures. Some results for astrophysical equations of state are presented, and the effects of condensation on opacity are briefly indicated. 18 refs.

33321 Three-dimensional kinematic reconnection in the presence of field nulls and closed field lines. Lau, Yuntung (Maryland Univ., College Park (USA)); Finn, J.M. *Astrophysical Journal (USA),* 350: 672-691 (Feb 1990).

The present investigation of three-dimensional reconnection of magnetic fields with nulls and of fields with closed lines gives attention to the geometry of the former, with a view to their gamma-line and Sigma-surface structures. The geometric structures of configurations with a pair of type A and B nulls permit reconnection across the null-null lines; these are the field lines which join the two nulls. Also noted is the case of magnetostatic reconnection, in which the magnetic field is time-independent and the electrostatic potential is constant along field lines. 31 refs.

33322 Limit on possible energy-dependent velocities for massless particles. Haines, T.J.; Alexandreas, D.E.; Allen, R.C.; Biller, S.; Berley, D.; Burman, R.L.; Cady, D.R.; Chang, C.Y.; Dingus, B.L.; Dion, G.M. *Physical Review, D (Particles Fields) (USA),* 41(2): 692-694 (15 Jan 1990).

A basic tenet of special relativity is that all massless particles travel at a constant, energy-independent velocity. Astrophysical data, including observation of the Crab pulsar at ~100 MeV and the recent detection of the pulsar in Hercules X-1 at energies $\geq$100 TeV, are used to place new experimental constraints on energy-dependent deviations from constant velocity for massless particles. Previous experiments reached energies ~10 GeV; this analysis improves the previous constraints by 7 orders of magnitude.

33323 Pulsar magnetospheres with jets. Sulkanen, M.E. (Cornell Univ., Ithaca, NY (USA)); Lovelace, R.V.E. *Astrophysical Journal (USA),* 350: 732-744 (Feb 1990).

The present study of Grad-Shafranov solutions for the ideal MHD flows around a magnetized rotating neutron star whose axes of rotation and magnetism are identical notes the force-free limit of this equation to be identical to the pulsar equation derived from a variational principle which minimizes the electromagnetic field energy within the constraints of fixed total angular momentum and total magnetic helicity. The pulsar equation is found to be a peacewise linear pdf with a class of solutions encompassing self-collimated electromagnetic jets along the star's rotation axis. 37 refs.

33324 Millisecond-pulsar constraint on cosmic strings. Bouchet, F.R. (Institut d'Astrophysique de Paris, 98 bis boulevard Arago, 75014 Paris, France (FR)); Bennett, D.P. *Physical Review, D (Particles Fields) (USA),* 41(2): 720-723 (15 Jan 1990). DOE Contract W-7405-ENG-48.

We study the gravity-wave background produced by a network of cosmic strings using high-resolution numerical simulations of string evolution. Our simulations show that the spectrum of loops produced by the network is dominated by the smallest loops that we can resolve. This reduces the amplitude of the gravity-wave background compared to previous estimates. Reasonable assumptions about how the string network will behave on scales that we cannot resolve indicate that strings with a mass per unit length of $\mu < 4\times10^{-6}c^2/G$ are consistent with the most recent limits on the gravity-wave background that come from millisecond-pulsar timing measurements.

33325 X-ray spectral signatures of photoionized plasmas. Liedahl, D.A. (California Univ., Berkeley (USA)); Kahn, S.M.; Osterheld, A.L.; Goldstein, W.H. *Astrophysical Journal (USA),* 350: L37-L40 (Feb 1990).

Plasma emission codes have become a standard tool for the analysis of spectroscopic data from cosmic X-ray sources. However, the assumption of collisional equilibrium, typically invoked in these codes, renders them inapplicable to many important astrophysical situations, particularly those involving X-ray photoionized nebulae. This point is illustrated by comparing model spectra which have been calculated under conditions appropriate to both coronal plasmas and X-ray photoionized plasmas. It is shown that the (3s-2p)/(3d-2p) line ratios in the Fe L-shell spectrum can be used to effectively discriminate between these two cases. This diagnostic will be especially useful for data analysis associated with AXAF and XMM, which will carry spectroscopic instrumentation with sufficient sensitivity and resolution to identify X-ray photoionized nebulae in a wide range of astrophysical environments. 25 refs.

6402 Atmospheric Physics

Refer also to citation(s) 33312, 33313

6403 Atomic, Molecular, and Chemical Physics

Refer also to citation(s) 32575, 32580, 32590, 32637, 32642, 32643, 32645, 32648, 32657, 32730, 32740, 32803, 32808, 32821, 32832, 32994, 33637, 33720

33326 (CBPF-NF-014/89) **Definition of a multicentral bond index.** Giambiagi, M.; Giambiagi, M.S. de; Mundim, K.C. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 21p. Order Number DE90627291. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The tensor character of the first-order density matrix leads to the definition of an MO multicentral bond index for closed-shell systems. It is here applied to three-center bonds. Satisfactory results are obtained for compounds involving 'secondary' bonds, strong and normal hydrogen bonds; the index for the peptide bond is found to be similar to that of strong hydrogen bonds. (author).

33327 (CONF-900190–1) **X-ray absorption spectroscopy: EXAFS [Extended X-ray Absorption Fine Structure] and XANES [X-ray Absorption Near Edge Structure]: A versatile tool to study atomic and electronic structure of materials.** Alp, E.E.; Mini, S.M.; Ramanathan, M. Argonne National Lab., IL (USA). Apr 1990. 14p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract W-31109-ENG-38. Contract STC-8809654. From Synchrotron x-ray sources and new opportunities in the agricultural and related sciences workshop; Argonne, IL (USA); 8-10 Jan 1990. Order Number DE90011177. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The x-ray absorption spectroscopy (XAS) had been an essential tool to gather spectroscopic information about atomic energy level structure in the early decades of this century. It has also played an important role in the discovery and systematization of rare-earth elements. The discovery of synchrotron radiation in 1952, and later the availability of broadly tunable synchrotron based x-ray sources have revitalized this technique since the 1970's. The correct interpretation of the oscillatory structure in the x-ray absorption cross-section above the absorption edge by Sayers et. al. has transformed XAS from a spectroscopic tool to a structural technique. EXAFS (Extended X-ray Absorption Fine Structure) yields information about the interatomic distances, near neighbor coordination numbers, and lattice dynamics. An excellent description of the principles and data analysis techniques of EXAFS is given by Teo. XANES (X-ray Absorption Near Edge Structure), on the other hand, gives information about the valence state, energy bandwidth and bond angles. Today, there are about 50 experimental stations in various synchrotrons around the world dedicated to collecting x-ray absorption data from the bulk and surfaces of solids and liquids. In this chapter, we will give the basic principles of XAS, explain the information content of essentially two different aspects of the absorption process leading to EXAFS and XANES, and discuss the source and samples limitations.

33328 (CONF-8906270–5) **The theory of electron-ion collisions: The role of doubly excited states.** Griffin, D.C. (Rollins Coll., Winter Park, FL (USA). Dept. of Physics); Pindzola, M.S.; Bottcher, C. Oak Ridge National Lab., TN (USA). [1989]. 28p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400;FG05-86ER53217. From Summer school of computational atomic and nuclear physics; Sewanee, TN (USA); 26 Jun - 7 jul 1989. Order Number DE90011078. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The important contributions of doubly excited autoionizing states to electron-impact excitation, ionization, and recombination are reviewed. Various theoretical methods of treating these states are considered, and theoretical cross sections are presented and compared to experimental measurements where available. 28 refs., 8 figs.

33329 (GSI–90-05) **Calculation of positron spectra from heavy-ion collisions and study of the line structure.** Sakaguchi, Kiyoshi. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.); Frankfurt Univ. (Germany, F.R.). Feb 1990. 184p. (In German). Order Number DE90792292. Available from NTIS (US Sales Only), PC A09/MF A01.

In this thesis the application of the EPOS positron solenoid spectrometer to the measurement of the quasi-atomic positron production in heavy ion collisions as well to the study of line structures is described. For the calculation of positron background contribution originating from nuclear internal pair production with the positron measurement simultaneously measured γ spectra were applied. These were extensively studied concerning their dependence on $Z_{ua}=Z_1+Z_2$, the incident energy, as well as the ion scattering angles. The multipolarity of the nuclear transitions of the exclusively heavy collisional systems ($163 \leq Z_{ua} \leq 188$) could be completely determined under inclusion of theoretical aspects on γ emission in the heavy-ion collision by the comparison of the calculated positron spectra with the experimental data. With the precise knowledge of the nuclear background the quasi-atomic theory is tested and confirmed in dependence on Z_{ua}, the incident energy, as well as the scattering angle in a wide range of Z_{ua} ($163 \leq Z_{ua} \leq 188$) at incident energies at the Coulomb barrier. For the theoretical quasi-atomic production probability a scaling factor $f_{QA}=1.0 \pm 0.1$ is derived. The excellent agreement of the quasi-atomic theory with the experiments allows subsequently the quantitative evaluation of the line structures observed with the EPOS spectrometer. This is performed extensively for the collisional systems $^{232}Th+^{232}Th$ in dependence on the incident energy as well the scattering angles. An angular distribution is indicated which hints to a connection of the line production with the reaching of the nuclear contact. (orig./HSI).

33330 (GSI–90-06) **Correlated positron-electron emission in heavy-ion collisions at the Coulomb barrier.** Salabura, P. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.); Uniwersytet Jagiellonski, Cracow (Poland). Feb 1990. 154p. Order Number DE90792271. Available from NTIS (US Sales Only), PC A08/MF A01.

In this thesis the experimental study of e^+e^--production in collisions of ^{238}U with ^{181}Ta and ^{232}Th at energies from 5.85 MeV/u to 5.90 MeV/u. Presented are positron spectra, electron spectra, and e^+e^- sum spectra. The possible origin of sharp lines in the sum spectra at 620 keV, 748 keV, and 806 keV as resulting from the decay of a narrow resonance is discussed. (HSI).

33331 (HASYLAB–88-05) **Electron spectroscopic investigation of atomic 4d giant resonances for Ba, La and lanthanides.** Richter, M. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.). Hamburger Synchrotronstrahlungslabor; Hamburg Univ. (Germany, F.R.). Fachbereich Physik. 1988. 127p. (In German). Available from Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.). Hamburger Synchrotronstrahlungslabor.

The $4d^{-1}(4, \epsilon)f$ giant resonances of atomic Ba, La and lanthanides have been studied by electron spectroscopy using undispersed and monochromatized synchrotron radiation of the storage rings BESSY and DORIS, as well as 1.5 keV electrons for excitation. The atomic vapours have been produced inside a high temperature furnace heated by electron bombardement. The measured spectra give detailled information about electron correlation effects and the character of the giant resonances. Starting from a $4d^{-1}\epsilon f$ atomic shape resonance at Ba they change into discrete $4d^{-1}4f$ excitations with increasing atomic number. Many-body theories succeed to describe the gross features of the determined partial cross-sections for photoionization of 4d, 4f, 5s, 5p, 5d and 6s shells. The experimental free atom ionization, Auger and resonance energy values have been compared with corresponding solid state results. The extra-atomic influence gives rise to energy shifts and valence changes. (orig.).

33332 (IC–89/228) **On the dynamic polarizability of atoms.** Nuroh, K. (International Centre for Theoretical Physics, Trieste (Italy)); Zaremba, E. International Centre for Theoretical Physics, Trieste (Italy). Apr 1989. 19p. Order Number DE90627292. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The positive frequency dependent polarizability of atoms is discussed in terms of the particle-hole polarization propagator. It is considered in the simplest approximation defined by the Bethe-Salpeter equation which includes a subset of particle-hole interactions to all orders in the Coulomb potential. Its solution is used to show the relationship between different formulations of atomic photoabsorption via the effective dipole matrix element (Fermi's 'golden rule'), the TDLDA and the reaction matrix. (author). 21 refs, 7 figs.

33333 (IC–89/320) **Strong-field Stark effect: Perturbation theory and 1/n-expansion.** Popov, V.S. (International Centre for Theoretical Physics, Trieste (Italy)); Mur, V.D.; Sergeev, A.V.; Weinberg, V.M. International Centre for Theoretical Physics, Trieste (Italy). Oct 1989. 24p. Order Number DE90627293. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The Stark shifts and the widths of the ground and excited states of a hydrogen atom are calculated. Two independent calculation methods are used: a summation of divergent perturbation-theory series and 1/n-expansion. The results of the calculations for the Rydberg ($n >> 1$) states are in agreement with the experiment. (author). 21 refs, 6 figs, 2 tabs.

33334 (IC–89/325) **1/n-expansion and scaling for the Stark effect in Rydberg atoms.** Popov, V.S. (International Centre for Theoretical Physics, Trieste (Italy)); Mur, V.D.; Sergeev, A.V. International Centre for Theoretical Physics, Trieste (Italy). Oct 1989. 20p. Order Number DE90627294. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The Stark shifts and widths of atomic states in an intense electric field are calculated with the help of 1/n-expansion. The previous theory is generalized to highly-excited states of an arbitrary atom. The scaling relations for nearthreshold (E approx. 0) resonances are obtained which are in a good agreement with experiment. The modifications of the Bohr-Sommerfeld quantization

rule due to the finite barrier penetrability is also considered. (author). 20 refs, 6 figs.

33335 (IFUSP-P–779) **Decay kinetics study of atomic hydrogen in a-Si:(H,O,N) and natural beryl.** Isotani, S.; Furtado, W.W.; Antonini, R.; Blak, A.R.; Pontuschka, W.M.; Castro, T.T.M. de; Rabbani, S.R. Sao Paulo Univ., SP (Brazil). Inst. de Fisica. Apr 1989. 25p. Order Number DE90625340. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A method of data processing was applied to the study of decay kinetics of interstial atomic hydrogen in X-irradiated a Sh(H,O,N) and UV-irradiated natural beryl. A system of differential kinetic equations was constructed considering multiple possible reactions. The solutions were evaluated by Runge-Kutta's method of numerical integration. It was assumed that the interstitial atomic hydrogen was proced by radiolytic irradiation of R-H type molecules and trapped at interstitial sites of both materials. The heating releases the atomic hydrogen which quickly is either retrapped, recombined with R-radical left in the matrix or combined with other atomic hydrogen atoms forming H_2 molecules. The parameters were fit to a function proportional to $T^{1/2-T_{01/2}}$, where T_0 is a constant. (author).

33336 (INS–786) **Mass systematics of hypothetical neutral objects in heavy-ion collisions and in e^+ heavy-ion interactions.** Sakai, Mitsuo. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Nov 1989. 10p. Order Number DE90791310. Available from NTIS (US Sales Only), PC A02/MF A01.

Studies on the energies of coincidence sum, singles electron peaks, and invariant masses are reviewed. It is postulated that the peaks represent excited states of an hypothetical object which would be an extended condensate having an internal structure. Close examination of the mass spectrum has shown a hidden mass formula of the form $L \propto M^3$, where L and M are the angular momentum and mass, respectively. It is quite possible that the object is an extended positron electron composite. If it is the case, the singlet $^1S_0$ and triplet $^3S_1$ states should be considered and can be expected to have series of excited states constructed on these different ground states which may correspond to even L and odd L series. It may be postulated that the potential for this unknown neutral object is expressed as $V(r) \propto r^2$ because $L \propto M^3$. The mass trajectory which results from the potential $V(r) \propto r^2$ is identified. To reinforce the validity of the mass rule, it is necessary to make experimental investigations of the existence of the 350-keV (L=1) and 1000-keV (L=6) sum peaks predicted by the rule. (N.K.).

33337 (INS–799) **A consistent treatment of medium effects on hypernuclear pi-mesonic decay.** Ericson, M. (Lyon-I Univ., 69 - Villeurbanne (France). Inst. de Physique Nucleaire); Bando, H. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Dec 1989. 15p. Order Number DE90791129. Available from NTIS (US Sales Only), PC A03/MF A01.

The theoretical treatment of the hypernuclear pi-mesonic decay is reformulated so that the pion distortion and the π-decay vertex renormalization are incorporated in a consistent manner, thus eliminating the dependence on the off-shell extensions of the π-N amplitude. Calculations are performed for some typical hypernuclei and compared to available experimental data. (author).

33338 (IPNO-TH–88-69) **About rainbow scattering in the presence of absorption.** Silveira, R. da. Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire. Dec 1988. 17p. Order Number DE90792986. Available from NTIS (US Sales Only), PC A03/MF A01.

We are concerned here with the role of the absorption in modifying the Airy-like shape of both the Coulomb and the nuclear rainbow angular distributions. The starting point of the present analysis is the quasi-classical limit of the high energy scattering amplitude. Using simple parametrizations for both the deflection function and the modulus of the S-matrix, one evaluates the resulting amplitude in the uniform approximation. This yields for the scattering cross-section a closed analytical expression suitable for a qualitative understanding of the angular distributions.

33339 (IPPCZ–293/II, pp. 102-104) **Simulation of relativistic electron and ion flows.** Vrba, P. (Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu). Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

Two-dimensional current tube program POISSON2 was used to simulate the steady state ion and relativistic electron flows in a cylindrical high-voltage diode with a hollow cathode and a plane anode in an external magnetic field. The spatial distribution of the electron emission current along the cathode surface was calculated together with the particle trajectories. It is shown that a very thin and laminar annular electron beam is formed while the ions perform pronounced radial oscillations. (J.U.). 3 figs., 2 refs.

33340 (KEK–89-14, pp. 53-62) **Electron acceleration by an electromagnetic wave.** Kawata, S. (Nagaoka Univ. of Technology, Niigata (Japan)); Manabe, A.; Watanabe, H. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Oct 1989. (CONF-8908213–: Workshop on role of plasmas in accelerators, Tsukuba (Japan), 21 Aug 1989). In *Proceedings of the workshop on role of plasmas in accelerators.* Order Number DE90759999. Available from NTIS (US Sales Only), PC A06/MF A01.

It is found that a charged particle can be efficiently accelerated by an electromagnetic (EM) wave with a static magnetic field. As a result, a particle can obtain the wave energy and be accelerated. Numerical analyses and simulation show that this mechanism works well for a high-energy electron acceleration. (author).

33341 (KFKI–1989-54/A) **Time evolution of the mass exchange in grazing heavy-ion collisions.** Bastrukov, S.I. (Eoetvoes Lorand Tudomanyegyetem, Budapest (Hungary). Atomfizikai Tanszek); Deak, F.; Kiss, A.; Seres, Z. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Oct 1989. 22p. Order Number DE90627305. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Nucl. Phys., A (NL).

On the basis of a macroscopical approach to the description of two interpenetrating quantum objects, the equations of two-fluid hydrodynamics for the cohesion stage of deeply inelastic heavy-ion collisions are formulated. The elasticity of the ions is analyzed in peripheral mass exchange reactions at intermediate energies. The system of closed equations of Newtonian mechanics, which simultaneously describes the motion of the ions along classical trajectories as well as the mass time evolution during the interaction period are derived and solved. The role of mass exchange in the friction force is discussed. (author) 22 refs.; 2 figs.

33342 **Atomic-scale modeling of low-energy ion-solid processes.** Dodson, B.W. (Sandia National Lab., Albuquerque, NM (US)). 137-150 of Processing and characterization of materials using ion beams. Rehn, L.E.; Greene, J.; Smidt, F.A. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811225–: Processing and characterization of materials using ion beams, Boston, MA (USA), 28 Nov - 2 dec 1988).

Various techniques which have been applied to modeling low-energy ($<<$ 1 keV) ion-solid interactions on an atomistic scale are described. In addition to their individual strengths, all such methods also have a number of drawbacks, both fundamental and practical. The range of validity, and the problems encountered external to this range, are outlined for the different approaches. Examples of molecular dynamics simulations of low-energy ion-solid interactions are presented.

33343 **The electron: its properties and reactions.** Holroyd, R.A. (Dept. of Chemistry, Brookhaven National Lab., NY (US)). 201-236 of Radiation chemistry: Principles and applications. Farhataziz; Rodgers, M.A.J. VCH Publishers Inc., New York, NY (USA) (1987).

This chapter begins with a brief account of the process occurring subsequent to ionization, involving thermalization of the electron, geminate recombination of the electron with ions, and escape to form free electrons. The times involved, as established by experiment, as well as the reactions that can occur in each of these stages are discussed. To understand the unusual chemical behavior of the electron it is important to first understand its physical

properties: drift mobility and energy levels. How these properties are measured is described in each case. The discussion shows how temperature, density, phase, and molecular structure affect each property, and the existing data are interpreted in terms of a modern theoretical framework. Finally, the recombination and attachment reactions of electrons are described and related to the physical properties. The story is incomplete in several aspects. One is that much remains undiscovered about the reactions and behavior of electrons. Also, space allows only brief generalizations and summaries.

33344 Deuterium interactions with ion-implanted oxygen in Cu and Au. Myers, S.M. (Sandia National Lab., Albuqerque, NM (US)); Follstaedt, D.M.; Swangley, W.A. 309-314 of Processing and characterization of materials using ion beams. Rehn, L.E.; Greene, J.; Smidt, F.A. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811225–: Processing and characterization of materials using ion beams, Boston, MA (USA), 28 Nov - 2 dec 1988).

This paper reports the interactions of deuterium (D) with oxygen in Cu and Au examined using ion implantation, nuclear-reaction analysis, and transmission electron microscopy. In Cu, the reduction of Cu_2O precipitates by D to produce D_20 was shown to occur readily down to room temperature, at a rate limited by the transport of D to the oxides. The reverse process of D_20 dissociation was characterized for the first time below the temperature range of steam blistering. The evolution of the Cu(D)-Cu_2O-D_20 system is shown to be predicted by a newly extended transport formalism encompassing phase changes, trapping, diffusion, and surface release. In Au, buried O sinks were used to measure the permeability of D at 573 and 373 K, thereby extending the range of measured permeabilities downward by about six orders or magnitude.

33345 Spectrum and energy levels of six-times-ionized molybdenum (Mo VII). Reader, J. (National Institute of Standards and Technology, Gaithersburg, Maryland 20899 (US)). *Journal of the Optical Society of America, Part B: Optical Physics (USA),* 7(3): 253-265 (Mar 1990).

The spectrum of the kryptonlike ion Mo VII was observed from 140 to 2274 A with sliding-spark discharges on 10.7-m normal- and grazing-incidence spectrographs. Experimental energies were determined for all levels of the $4s^24p^6$, $4s^24p^54d$, $4f$, $5s$, $5p$, $5d$, $5f$, $5g$, and $4s4p^64d$ configurations. A few levels of the $4s^24p^44d^2$ configuration were also found. A total of 399 lines were classified as transitions between 86 observed levels. The observed configurations were theoretically interpreted. The energy parameters determined by least-squares fits to the observed levels are compared with Hartree–Fock calculations. A revised value of the ionization energy was obtained by using the energy of the $4p^55g$ configuration together with an isoelectronically extrapolated value of the effective quantum number $n(5g)$. The adopted limit is 1 013 340±200 cm^{-1} (125.64±0.02 eV).

33346 Comments on relativistic correlation. Kim, Y. (National Institute of Standards Technology, Gaithersburg, Maryland 20899 (USA)). *AIP Conference Proceedings (American Institute of Physics) (USA),* 189(1): 272-284 (15 Jun 1989). (CONF-8807162–: Relativistic, quantum electrodynamic, and weak interaction effects in atoms, Santa Barbara, CA (USA), Jul 1988).

Effects of electron correlation on relativistic corrections are illustrated by calculating the fine-structure energy levels of aluminium-like ions, $3p\ ^2P_{1/2}$ and $^2P_{3/2}$, with single- and multiconfiguration Dirac-Fock wave functions. While the dominant behavior of the correlation contribution to the Breit interaction for the $J=3/2$ level varies as Z^6, as expected, that for the $J=1/2$ level varies as Z^2. The dominant behavior of the correlation contribution to the Lamb shift for both levels varies as Z^6. We used hydrogenic values of the self energy without any screening by other bound electrons and hence the correlation effect we have seen results from the redistribution of configuration weights in the correlated wave functions. These weights themselves have a weak $Z\alpha$ dependence though they are expected to approach constant values as $Z\rightarrow\infty$.

33347 Production of atomic nitrogen ion beams. Walther, S.R. (Accelerator Division, Lawrence Berkeley Laboratory, 1 Cyclotron Road, Brekely, California 94720 (USA)); Leung, K.N.; Kunkel, W.B. *Review of Scientific Instruments (USA),* 61(1): 315-317 (Jan 1990). DOE Contract AC03-76SF00098. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

A small multicusp ion source has been used to generate beams of nitrogen ions. To achieve a high percentage of N^+ ions, the source was equipped with a magnetic filter and operated with a high N_2 gas density. A nearly pure atomic nitrogen ion (N^+) beam (98.5% N^+, 1.5% N_2^+), suitable for implantation purposes, was produced. The operating characteristics of this source, including species mix, are presented.

33348 The many faces of resonances in multiphoton ionization. Tang, X. (Department of Physics, University of Southern California, Los Angeles, California 90089-0484 (USA)); Lyras, A.; Lambropoulos, P. *Journal of the Optical Society of America, Part B: Optical Physics (USA),* 7(4): 456-462 (Apr 1990). DOE Contract FG03-87ER60504.

We present a theoretical analysis of multiphoton ionization through resonant intermediate states shifted through resonance during a short, intense pulse. The resonant structure in the photoelectron spectra is compared with what it would be if the peak intensity or the frequency of the laser were scanned, and the various differences are discussed in detail. The dynamical behavior is described in terms of a density matrix evolving under a realistic temporal and spatial pulse shape. Our results, on atoms with realistic parameters, show structure similar to that observed in recent experiments. Results for circularly polarized light are also presented. The limitations and advantages of the model are discussed.

33349 Testing of a H_2^+-enriched ion source for deuterium simulation. Williams, M.D. (Lawrence Berkeley Laboratory, Berkeley, California 94720 (US)); Leung, K.N.; Brennen, G.M.; Burns, D.R. *Review of Scientific Instruments (USA),* 61(1): 475-477 (Jan 1990). DOE Contract AC03-76SF00098. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

We have tested a McDonnell Douglas short milticusp plasma generator, designed to generate a positive hydrogen ion beam which is enriched with H_2^+ ions. Initial testing shows that the prototype source is capable of producing a positive hydrogen ion beam with H_2^+ percentage greater than 85%. The total ion-current density was 56 mA/cm^2. For a higher current density of 110 mA/cm^2, the percentage of H_2^+ ions is approximately 73% as measured by a magnetic deflection spectrometer. A comparison between tungsten and lanthanum hexaboride cathodes shows that tungsten filaments can provide better performance.

33350 QED potentials in many-electron atoms. Zygelman, B. (Center for Astrophysics, Harvard University, 60 Garden Street, Cambridge, MA 02138 (USA)). *AIP Conference Proceedings (American Institute of Physics) (USA),* 189(1): 408-427 (15 Jun 1989). (CONF-8807162–: Relativistic, quantum electrodynamic, and weak interaction effects in atoms, Santa Barbara, CA (USA), Jul 1988).

A many-electron configuration space equation is obtained using a combination of the no-pair approximation and a series of decoupling transformations in Fock space. The contribution of QED three-body potentials to the structure of heavy atoms is discussed. Some remarks concerning the non-uniqueness, or gauge dependence, of the two-electron potential are made.

33351 Testing of laser-dressed atomic states. Janjusevic, M. (Department of Physics, University of Connecticut, Storrs, Connecticut 06269 (USA)); Hahn, Y. *Journal of the Optical Society of America, Part B: Optical Physics (USA),* 7(4): 592-597 (Apr 1990).

A simple procedure of dressing the atomic states distorted in the presence of a potential, bound or continuum, by a laser field is discussed, and the validity of the developed dressing procedure is tested by evaluating the harmonic generation and multiphoton ionization processes for a one-dimensional model potential of the form $V(x) = -(1 + x^2)^{-1/2}$. The results are compared with the exact one-dimensional model calculations of Eberly *et al.* for the same processes [Phys. Rev. Lett. 62, 881 (1989)]. Several other dressed-state wave functions proposed by other authors are also tested.

33352 Generation of optical harmonics by intense pulses of laser radiation. II. Single-atom spectrum for xenon. Kulander, K.C. (Theoretical Atomic Molecular Physics Group, Lawrence Livermore National Laboratory, Livermore, California 94550 (USA)); Shore, B.W. *Journal of the Optical Society of America, Part B: Optical Physics (USA),* 7(4): 502-508 (Apr 1990). DOE Contract W-7405-ENG-48.

Using time-dependent Hartree–Fock theory, we describe the results of calculations of dipole moments induced in xenon by 1.064-nm radiation of intensities in the range 10^{13}–10^{14} W/cm^2. The calculated spectrum comprises sharply defined optical harmonics to order 61. We comment on the three-dimensional properties of our calculated induced dipole moments and on the spectral background underlying these harmonics.

33353 Broad-beam multi-ampere metal ion source. Brown, I.G. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720 (US)); Galvin, J.E.; MacGill, R.A.; Paoloni, F.J. *Review of Scientific Instruments (USA),* 61(1): 577-579 (Jan 1990). DOE Contract AC03-76SF00098. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

An embodiment of the MEVVA (metal vapor vacuum arc) high current metal ion source has been developed in which the beam is formed from a 10-cm-diam set of extractor grids and which produces a peak beam current of up to several amperes. The source, MEVVA V, operates in a pulsed mode with a pulsewidth, at present, of 0.25 ms and a repetition rate of up to several tens of pulses per second (power supply limited). The multi-cathode feature that was developed for the prior source version, MEVVA IV, has been incorporated here also; one can switch among any of 18 separate cathodes and thus metallic beam species. Maximum beam extraction voltage is over 90 kV, and since the ion charge states are typically from Q=1 to 5, depending on the metal employed, the ion energy in the extracted beam can thus be up to several hundred keV. This source is a new addition to the MEVVA family of metal ion sources, and we are at present investigating the operational regimes and the limits to the source performance. In this article we describe the source, and present some preliminary results.

33354 Ion spectra of the metal vapor vacuum arc ion source with compound and alloy cathodes. Sasaki, J. (Nippon Steel Corporation, 10-1 Fuchinobe 5-chome, Sagamihara-shi, Kanagawa 229, Japan (JP)); Brown, I.G. *Review of Scientific Instruments (USA),* 61(1): 586-588 (Jan 1990). DOE Contract AC03-76SF00098. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

In metal vapor vacuum arc (MEVVA) ion sources, vacuum arc plasma with cathodes of single, pure elements has been utilized for the production of metal ions. In this study, we have investigated the charge state distributions of ions produced in vacuum arc plasmas in a MEVVA ion source for the case when the cathode is an alloy or a compound material. The ion charge state spectra were analyzed by means of a time-of-flight apparatus. We have compared the ion spectra for a cathode of an alloy or a compound material with its constituent elements: TiC/TiN/TiO_2/Ti/C, SiC/Si/C, WC/W/C U/UN/(UN-ZrC)/Zr/C, and brass/Zn/Cu. We find that the MEVVA produces ions of all constituent elements in the compound and the alloy cathodes. The charge state distribution of each element differs, however, from the charge state distribution obtained in the vacuum arc with a cathode made of the pure, single constituent element. Fractional values of the total ion numbers of each constituent element in the extracted beam depart from the stoichiometry of the elements in the cathode material. In an operation with a TiC cathode, we irradiated a 304 stainless-steel plate with the extracted beam. Results from glow-discharge spectroscopy (GDS) of the surface show that both titanium and carbon are implanted in the substrate after the irradiation.

33355 Operational characteristics of a metal vapor vacuum arc ion source. Shiraishi, H. (Nippon Steel Corporation, 46-59 Nakabaru, Tobata-ku, Kitakyusyu-city 804, Japan (JP)); Brown, I.G. *Review of Scientific Instruments (USA),* 61(1): 589-591 (Jan 1990). DOE Contract AC03-76SF00098. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

The MEVVA ion source can produce high current pulsed beams of metallic ions using a metal vapor vacuum arc discharge as the plasma medium from which the ions are extracted. In this study, the operational characteristics of the MEVVA IV ion sources are summarized. Results are presented of measurements of the ion beam current as a function of arc current over a range of extraction voltage. Ti, Ta, and Pb were examined as the cathode materials. The arc current ranged from 50 to 250 A and the extraction voltage from 10 to 80 kV. The ion beam current was measured at two different distances from the ion source using Faraday cups, so as to investigate the beam divergence. Additionally, the cathode erosion rates were measured. Optimum operating conditions of the MEVVA ion source were determined.

33356 Laser effects in photoionization: numerical solution of coupled equations for a three-dimensional Coulomb potential. LaGattuta, K.J. (Los Alamos National Laboratory (MS B-257), Los Alamos, New Mexico 87545 (USA)). *Journal of the Optical Society of America, Part B: Optical Physics (USA),* 7(4): 639-646 (Apr 1990).

The time-dependent Schroedinger equation was solved numerically as a set of coupled equations for an electron moving in three spatial dimensions, bound initially ($t \times 0$) by a Coulomb potential, and acted on by a linearly polarized, single-frequency, classical electromagnetic field that is turned on abruptly at $t = 0$. The laser field was assumed to be spatially homogeneous, and magnetic interactions between the laser beam and the electron were ignored. Characteristic photoionization times were determined for a wide range of scaled laser intensities and scaled laser frequencies and for a range of electron initial-state quantum numbers *nlm*. Results are compared with those obtained previously [Phys. Rev. A 40, 683 (1989)] for a one-dimensional δ potential.

33357 Atoms in strong, oscillating electric fields: momentum-space solutions of the time-dependent, three-dimensional Schroedinger equation. Collins, L.A. (Group T-4, MS B212, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (USA)); Merts, A.L. *Journal of the Optical Society of America, Part B: Optical Physics (USA),* 7(4): 647-658 (Apr 1990).

We have developed a procedure for solving the three-dimensional, time-dependent Schroedinger equation by expanding the total system wave function in a Volkov basis and by propagating the resulting first-order differential equations in time. We discuss applications to several model systems representing an atom in an intense, oscillating electric field.

33358 Strong-field laser ionization of alkali atoms using two-dimensional cylindrical and three-dimensional Cartesian time-dependent Hartree–Fock theory. Pindzola, M.S. (Department of Physics, Auburn University, Auburn, Alabama 36849 (USA)); Bottrell, G.J.; Bottcher, C. *Journal of the Optical Society of America, Part B: Optical Physics (USA),* 7(4): 659-664 (Apr 1990). DOE Contract AC05-84OR21400.

The time-dependent Schroedinger equation is solved directly for an alkali atom subject to an arbitrarily strong electromagnetic field. Two methods are compared. A tridiagonal finite-difference method is used to solve Schroedinger's equation on a two-dimensional (2D) cylindrical coordinate lattice, while a finite-element method using odd-order B splines is used to solve Schroedinger's equation on a three-dimensional (3D) Cartesian coordinate lattice. Multiphoton ionization cross sections are extracted from 2D cylindrical calculations for hydrogen and lithium and then compared with previous perturbation theory results. Single-photon ionization probabilities are compared from 2D cylindrical and 3D Cartesian calculations for hydrogen.

33359 Variable time-step integrator for intense field dynamics. Cerjan, C. (Lawrence Livermore National Laboratory, Livermore, California 94550 (USA)). *Journal of the Optical Society of America, Part B: Optical Physics (USA),* 7(4): 680-684 (Apr 1990). DOE Contract W-7405-ENG-48.

A modification of the well-known Lanczos algorithm is described that adapts the method to explicitly time-dependent solutions of the Schroedinger equation. This technique possesses the desirable feature of variable time-step integration, thus eliminating the difficulties associated with fixed time-step integration schemes. Results

are presented for a one-dimensional system: the so-called soft Coulomb potential in the presence of a harmonic electromagnetic field. It is demonstrated that the Lanczos propagation scheme can be efficiently and accurately used from the perturbative limit to the strong-field limit.

33360 Variational methods for high-order multiphoton processes. Gao, B. (Department of Physics— Department of Astronomy, University of Nebraska, Lincoln, Nebraska 68588-0111 (USA)); Pan, C.; Liu, C.; Starace, A.F. *Journal of the Optical Society of America, Part B: Optical Physics (USA),* 7(4): 622-630 (Apr 1990). DOE Contract FG02-88ER13955.

Methods for applying the variationally stable procedure for Nth-order perturbative transition matrix elements of Gao and Starace [Phys. Rev. Lett. **61**, 404 (1988); Phys. Rev. A **39**, 4550 (1989)] to multiphoton processes involving systems other than atomic H are presented. Three specific cases are discussed: one-electron ions or atoms in which the electron–ion interaction is described by a central potential; two-electron ions or atoms in which the electronic states are described by the adiabatic hyperspherical representation; and closed-shell ions or atoms in which the electronic states are described by the multiconfiguration Hartree–Fock representation. Applications are made to the dynamic polarizability of He and the two-photon ionization cross section of Ar.

33361 SIMION PC/PS2 electrostatic lens design program. Dahl, D.A. (Idaho National Engineering Laboratory, EG&G Idaho, POB 1625 Idaho Falls, Idaho 83415 (USA)); Delmore, J.E.; Appelhans, A.D. *Review of Scientific Instruments (USA),* 61(1): 607-609 (Jan 1990). (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

SIMION PC/PS2 4.02 is a personal computer program for designing and analyzing charged particle (ions and electrons) lenses, ion transport systems, and various types of mass spectrometers and surface probes that utilize charged particles. The modification of an existing design or the generation of a completely new one is performed interactively with a graphics screen and mouse. Once the geometry has been defined, the operating conditions (electrode voltages and magnetic field configuration) can be quickly changed and the resultant fields viewed in several different 2D and 3D modes. The trajectories of charged particles moving in these fields are calculated utilizing sophisticated "look-ahead" algorithms that dynamically control the time step to optimize speed and accuracy. A unique graphics display of the electrostatic fields and ion trajectories gives the user an intuitive, easily understood view of the performance characteristics. SIMION also includes a totally integrated capability for users to easily construct subprograms, which are automatically compiled and integrated into the main program, for defining and controlling all of the major functions of trajectory calculations. This makes it possible to model dynamic electric fields (e.g., rf), including ion-molecule collisions or neutralizations, etc. Operational experience with specific ion lenses designed with SIMION and tested in several different applications are discussed. SIMION PC/PS2 is available upon written request for the cost of distribution.

33362 An autoneutralizing neutral molecular beam gun. Delmore, J.E. (Idaho National Engineering Laboratory, EG&G Idaho, Inc., Box 1625, Idaho Falls, Idaho, 83415 (USA)); Appelhans, A.D.; Dahl, D.A. *Review of Scientific Instruments (USA),* 61(1): 633-635 (Jan 1990). (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

A high-energy (up to 28 keV) neutral molecular beam gun has been developed and put into routine use that takes advantage of the autoneutralization properties of the sulfur hexafluoride anion for the production of high-energy sulfur hexafluoride neutral molecules. The anions are produced in an electron-capture source, accelerated, and focused in a lens assembly designed to minimize residence time, allowed to drift at their terminal velocity for a suitable distance during which up to 30% auto-eject an electron, and all remaining charged particles are electrostatically skimmed, resulting in a focused neutral beam. Rasterable neutral beams focused to a 5-mm spot size up to 3 m from the source have been produced with beam currents up to 40 pA equivalent. Spot sizes of 1 mm can be produced with intensity levels of a few picoamperes equivalent.

33363 Solid state cesium ion guns for surface studies. Souzis, A.E. (Physics & Engineering Physics Department, Stevens Institute of Technology, Hoboken, New Jersey 07030 (US)); Carr, W.E.; Kim, S.I.; Seidl, M. *Review of Scientific Instruments (USA),* 61(1): 658 (Jan 1990). (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

Short communication. CESIUM IONS/ion sources; CESIUM IONS/deposition; ION SOURCES/design; ION SOURCES/beam currents; DEPOSITION; DESIGN; BEAM EXTRACTION; ION IMPLANTATION

33364 Angular distribution of Auger electrons and photons in resonant transfer and excitation in collisions of ions with light targets. Bhalla, C.P. (Department of Physics, Cardwell Hall, Kansas State University, Manhattan, Kansas 66506-2601 (USA)). *Physical Review Letters (USA),* 64(10): 1103-1106 (5 Mar 1990).

It is shown that angular distributions of Auger electrons and x rays from deexcitation of doubly excited states produced in the resonant transfer and excitation of projectiles in collisions with light targets are, in general, not isotropic. The detailed theoretical results for the $2p^2\,^1D$ resonance in $F^{6+}+H_2$ are presented at a projectile energy of 20 MeV.

33365 Comment on "Charge exchange and metastability of small multiply charged gold clusters". Li, Y. (Physics Department, Virginia Commonwealth University, Richmond, Virginia 23284-2000 (USA)); Khanna, S.N.; Jena, P. *Physical Review Letters (USA),* 64(10): 1188 (5 Mar 1990). DOE Contract FG05-87ER45316.

A Comment on the Letter by W. A. Saunders, Phys. Rev. Lett. 62, 1037 (1989).

33366 Electron-suppression experiments in a small multicusp H^- source. Leung, K.N. (Accelerator Research Division—Fusion Research Division, Lawrence Berkeley Laboratory, 1 Cyclotron Road, Berkeley, California 94720 (US)); Hauck, C.A.; Kunkel, W.B.; Walther, S.R. *Review of Scientific Instruments (USA),* 61(3): 1110-1116 (Mar 1990). DOE Contract AC03-76SF00098.

Several techniques for suppressing the electrons before they form part of the extracted beam have been studied in a small multicusp H^- source. It is found that some schemes reduce both the electron and the H^- output currents. Other approaches, such as the installation of a collar at the extraction aperture, the addition of xenon or cesium to the hydrogen discharge, or the reduction of the source plasma potential, not only can reduce the electron current substantially, but bring about an enhancement in the extracted H^- current.

33367 Two-body fragmentation channels of three-body systems. Cavagnero, M. (Department of Physics, University of Nebraska-Lincoln, Lincoln, Nebraska 68588-0111 (USA)); Zhen, Z.; Macek, J. *Physical Review, A (General Physics) (USA),* 41(3): 1225-1237 (1 Feb 1990). DOE Contract FG02-88ER13955.

An asymptotic expansion of the wave functions for the fragmentation channels of three-body systems is developed in hyperspherical coordinates. It is shown that, to any finite power in $1/R$, where $mR^2=$ is the trace of the inertia tensor, the expanded wave function is an analytic finite sum of Sturmian functions. The expansion is carried out explicitly through order $1/R^4$. These asymptotic states converge (as $R\to\infty$) to polarized orbitals for two-electron systems, and also provide improved dissociation channels for molecular ions, such as HD^+. Asymptotic potential curves for He and μ^--H systems are presented as illustrations.

33368 Muon reactivation in muon-catalyzed d-t fusion from accurate p-He^+ stripping and excitation cross sections. Stodden, C.D. (Quantum Theory Project, Department of Physics, University of Florida, Gainesville, Florida 32611 (USA)); Monkhorst, H.J.; Szalewicz, K.; Winter, T.G. *Physical Review, A (General Physics) (USA),* 41(3): 1281-1292 (1 Feb 1990).

Accurate cross sections are obtained for the excitation and stripping of a muon from $\alpha\mu$ in collisions with hydrogen atoms. This is done by calculating the excitation, ionization, and charge-transfer cross sections for the p-He^+ collision and scaling the results. An impact-parameter coupled-state method with a basis set of up to 51 Sturmian wave functions is used to obtain cross sections at

center-of-mass energies ranging from 20 to 600 keV. Along with Stark, Auger, radiative, and stopping rates these cross sections are used to calculate the probability of stripping a muon from $\alpha\mu$ by numerically solving a set of coupled differential equations that describe the kinetics of $\alpha\mu$ as it travels through a mixture of D_2 and T_2. An effort has been made to minimize the uncertainty in the value of the stripping probability resulting in error bars of 9% and 11% at densities of 1.2 and 0.05 times liquid-hydrogen density, respectively. X-ray yields belonging to *K* and *L* series transitions among $\alpha\mu$ states have also been computed. The present results are compared with recent theoretical and experimental data.

33369 Positron–hydrogen-atom *S*-wave coupled-channel scattering at low energies. Archer, B.J. (Department of Physics, University of Oklahoma, Norman, Oklahoma 73019 (USA)); Parker, G.A.; Pack, R.T. *Physical Review, A (General Physics) (USA)*, 41(3): 1303-1310 (1 Feb 1990).

Results are presented for both inelastic and rearrangement scattering of positrons by hydrogen atoms for total angular momentum of zero. Sector adiabatic basis functions in hyperspherical coordinates are used to form a 43-coupled-channel scattering expansion for energies below the H(n=4) threshold. Partial cross sections out of e^++H(1) into H(1), Ps(1), H(2), Ps(2), and H(3) are shown, as are those out of p^++Ps(1) into H(2), Ps(2), and H(3). Considerable resonance structure is apparent in all of these cross sections.

33370 Correlation enhancement of the electron-impact ionization cross section for excited-state Ne-like ions. Pindzola, M.S. (Department of Physics, Auburn University, Auburn, Alabama 36849 (USA)); Griffin, D.C.; Bottcher, C. *Physical Review, A (General Physics) (USA)*, 41(3): 1375-1382 (1 Feb 1990).

The electron-impact ionization cross section is calculated in the distorted-wave approximation for the Ne-like ions Ar^{8+}, Ti^{12+}, Fe^{16+}, Zn^{20+}, and Se^{24+}. For ionization from the $2p^6$ ground state, the contributions from inner-shell excitation followed by autoionization are negligible. However, when these ions are initially in the $2p^53s$ excited configuration, contributions arising from the inner-shell excitations $2p^53s \rightarrow 2p^43snl$ and $2p^53s \rightarrow 2s2p^53snl$ are large. The overall branching ratio for autoionization of the $2p^43snl$ and $2s2p^53snl$ levels increases when the atomic-structure calculations are extended beyond the single-configuration approximation to include the configuration interaction. The resulting correlation enhancement of the excited-state ionization cross section is found to increase as a function of *Z*. For Se^{24+} the correlation enhancement of the total ionization cross section is found to be 42%.

33371 Charge-transfer reactions of ground-state $C^+(^2P)$ and metastable-state $C^+(^4P)$ ions with H_2 molecules. Xu, Y. (School of Chemistry, Georgia Institute of Technology, Atlanta, Georgia 30332 (USA)); Moran, T.F.; Thomas, E.W. *Physical Review, A (General Physics) (USA)*, 41(3): 1408-1412 (1 Feb 1990).

Cross sections for charge-transfer reactions of ground-state $C^+(^2P)$ and metastable-state $C^+(^4P)$ ions with H_2 have been measured in the 10- to 500-eV kinetic energy range. Ground-state reaction cross sections range from 0.3 to 0.5×10^{-16} cm^2, and the corresponding values for metastable state $C^+(^4P)$ ions vary from 20 to 12×10^{-16} cm^2. Both sets of cross-section values smoothly extrapolate to previously measured data at higher energies.

33372 Collisional relaxation of the $6s[3/2]_1^0$ and $6s'[1/2]_1^0$ m_J levels of xenon using resonantly enhanced multiphoton ionization. Charalambidis, D. (Foundation for Research, P.O. Box 1527, Heraklio Crete, 71110 (Greece)); Lyras, A.; Lambropoulos, P.; Tang, X.; Bajic, S.J.; Compton, R.N. *Physical Review, A (General Physics) (USA)*, 41(3): 1457-1465 (1 Feb 1990). DOE Contract FG03-87ER60504.

Collisional relaxation of the $6s[3/2]_1^0$ and $6s'[1/2]_1^0$ m_J levels of Xe has been investigated both experimentally and theoretically. Collisional disalignment and dephasing of the m_J levels have been studied by measuring the pressure and laser intensity dependence of the ratio of the ionization from selectively excited m_J=0 and ±1 sublevels in a three-photon resonant-ionization experiment via the 6*s* and 6*s'* states of Xe. The selective ionization is achieved by a novel use of two counterpropagating laser beams having parallel and orthogonal polarization, respectively. The pressure dependence of the ionization ratio has been calculated by solving a system of rate equations derived from a full set of density-matrix equations pertaining to the particular experimental conditions. Collisional-relaxation cross sections of the investigated levels have been estimated by fitting the calculated results to the experimental data. The ionization ratio is found to be sensitive to both disalignment and dephasing of the m_J levels.

33373 Variational expressions for first-order properties involving continuum wave functions. Orel, A.E. (Department of Applied Science, University of California-Davis, Livermore, California 94550 (USA)); Rescigno, T.N. *Physical Review, A (General Physics) (USA)*, 41(3): 1695-1697 (1 Feb 1990). DOE Contract W-7405-ENG-48.

We discuss methods for computing first-order matrix elements involving continuum wave functions variationally. Specifically, we show that the trial wave function obtained from the Kohn method will give a variational result for any first-order property. We also discuss a variational technique for computing the squared modulus of a first-order matrix element based on approximating the resolvent. We explain why the resolvent method will converge more slowly in certain cases and illustrate our remarks with calculations on a model problem.

33374 Improved many-body perturbation theory calculations of the n=2 states of lithiumlike uranium. Blundell, S.A. (Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556 (USA)); Johnson, W.R.; Sapirstein, J. *Physical Review, A (General Physics) (USA)*, 41(3): 1698-1700 (1 Feb 1990). DOE Contract W-7405-ENG-48.

A recent calculation of the spectrum of the n=2 states of lithium-like uranium is improved by a more accurate treatment of the effect of finite nuclear size and a more complete calculation of higher-order corrections to Breit and mass-polarization contributions. Predictions for the $2s_{1/2}$-$2p_{1/2}$ and $2p_{1/2}$-$2p_{3/2}$ splittings, incorporating a phenomenological treatment of radiative corrections, are presented.

33375 Nuclear-charge screening in electron capture. Alston, S. (Physics Department, Pennsylvania State University, Wilkes-Barre Campus, Lehman, Pennsylvania 18627 (US)). *Physical Review, A (General Physics) (USA)*, 41(3): 1705-1708 (1 Feb 1990).

Within the boundary-corrected first Born approximation to the exact electron-transfer amplitude, a simple model is presented for representing the complex interactions between the projectile and the target nucleus plus nonactive electrons existing in an ion-atom collision. The one-electron Hartree-Fock density derived from the occupied orbitals is used. For proton-helium scattering comparison is made with the results obtained using strictly Coulomb potentials and with other screening results.

33376 Autoionization rates for selected double-Rydberg states of barium. Bhalla, C.P. (Department of Physics, Kansas State University, Manhattan, Kansas 66506 (USA)); Karim, K.R.; Wilson, M. *Physical Review, A (General Physics) (USA)*, 41(3): 1715-1717 (1 Feb 1990).

We have performed *ab initio* calculations of several autoionizing double-Rydberg states of Ba. We have also investigated the effects due to electron configuration mixing. These calculations are based on the Hartree-Fock atomic model. Numerical results are presented and are compared with the experimental data for *msn'sandmsn'd* states. Although our calculated quantum-defect values are in excellent agreement with experimental values, they do not yield the same dependence of the scaled autoionization rates on the core principal quantum number as deduced from experiment.

33377 Reply to "Comment on 'Fine-structure and analytical quantum-defect wave functions' ". Kostelecky, V.A. (Department of Physics, Indiana University, Bloomington, Indiana 47405 (USA)); Nieto, M.M.; Truax, D.R. *Physical Review, A (General Physics) (USA)*, 41(3): 1732-1734 (1 Feb 1990).

The preceding Comment by Goodfriend [Phys. Rev. A 41, 1730 (1990)] contains three criticisms of our model for analytical quantum-defect wave functions *vis-a-vis* the atomic Fues potential of Simons [J. Phys. Chem. 55, 756 (1971)]. We rebut the first two

criticisms explicitly. This makes the third criticism moot. We stand by our results.

33378 Production of N_2^+ first negative emission by impact of 1-MeV H^0, H^+, and H^- on N_2. Holland, R.F. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (USA)); Cobb, D.D.; Maier, W.B. II; Clodius, W.B.; O'Shea, P.G.; Bos, R.; Frogget, B.C. *Physical Review, A (General Physics) (USA),* 41(5): 2429-2436 (1 Mar 1990).

Absolute cross sections for the production of photons in the N_2^+ first negative (0-0) and (0-1) bands by collisions of 1-MeV H^0, H^-, and H^+ on N_2 have been measured. The (0-0) cross sections are, respectively, 0.091±0.03, 0.19±0.06, and 0.15±0.05 A^2 per N_2 molecule, for H^0, H^-, and H^+ projectiles. The (0-1) cross section is 0.060±0.02 A^2 per N_2 molecule for H^- projectiles. Pressure dependences are observed in the apparent cross sections for $H^0+N_2 \rightarrow 391$ nm and $H^-+N_2 \rightarrow 391$ nm, at nitrogen pressures below 3.5×10^{-4} torr, and are ascribed to stripping of electrons from H^0 and H^-. The cross section for $H^-+N_2 \rightarrow H^0+...$ is measured to be 6.8(+2.3,−2.9) A^2 per N_2 molecule. Where data for comparison exist, our measured cross sections are a factor of 2 or more higher than previously reported values.

33379 Electronic excitation of formaldehyde by low-energy electrons: A theoretical study using the complex Kohn variational method. Rescigno, T.N. (Lawrence Livermore National Laboratory, P.O. Box 808, Livermore, California 94550 (USA)); Lengsfield, B.H. III; McCurdy, C.W. *Physical Review, A (General Physics) (USA),* 41(5): 2462-2467 (1 Mar 1990). DOE Contract W-7405-ENG-48.

We report results of a fully *ab initio* treatment of electronic excitation in a polyatomic molecule by electron impact. We have calculated total and differential cross sections for exciting the two lowest $(n\rightarrow\pi^*)^{1,3}A_2$ excited states of H_2CO for collision energies between 5 and 20 eV. The calculations were carried out in a three-state close-coupling approximation using the complex Kohn variational method. The absence of any backward peaking in the cross sections calculated for the $^3A_2$ state is reminiscent of a rigorous selection rule for Σ^+-Σ^- transitions in linear molecules. However, with no experimental studies available for comparison, the present results must be regarded as predictive.

33380 Hanle effect in spectrally broadened light. Arnett, K. (Joint Institute for Laboratory Astrophysics, Boulder, CO (USA)— University of Colorado, Boulder, CO (USA)— National Institute for Standards and Technology, Boulder, Colorado 80309 (USA)); Smith, S.J.; Ryan, R.E.; Bergeman, T.; Metcalf, H.; Hami *Physical Review, A (General Physics) (USA),* 41(5): 2580-2593 (1 Mar 1990).

We have carried out experimental and theoretical investigations of the Hanle effect in the $^1S_0 \rightarrow {}^3P_1$ transition at λ=555.6 nm in ^{174}Yb, emphasizing the dependence of the Hanle signal on the intensity and on the statistical parameters of a well-characterized phase-diffusing optical field. The phase and frequency fluctuations imposed on the laser beam by a system of modulators are described by two parameters corresponding to the bandwidth β and the spectral density b of the noise spectrum. The shape of the laser power spectrum is continuously variable between nearly Gaussian ($b/\beta \gg 1$) and nearly Lorentzian ($b/\beta \ll 1$). Measurements are made with a well-collimated Yb atomic beam crossed at right angles by a linearly polarized laser beam. In accord with theoretical predictions, the full width at half maximum (FWHM) of the Hanle effect coherence dip is found to increase as the square root of the laser intensity for monochromatic excitation. For a given intensity, the FWHM decreases as the laser bandwidth increases. With the same laser intensity and spectral width, the FWHM of the Hanle coherence dip increases as the laser spectral profile approaches the Gaussian limit, particularly when $\beta/2\pi$ is within an order of magnitude of the natural width of the atomic line. The Hanle signal shapes agree well with theoretical calculations using a Brownian motion phase-diffusion model of the laser field. For large β, it suffices to apply substitution rules for simple phase diffusion to the density-matrix equations.

33381 Enhanced radiative Auger emission from lithiumlike $_{16}S^{13+}$. Bernstein, E.M. (Department of Physics, Western Michigan University, Kalamazoo, Michigan 49008 (USA)); Clark, M.W.; Oglesby, C.S.; Tanis, J.A.; Graham, W.G.; McFarland, R.H.; Morgan, T.J.; Johnson, B.M. *Physical Review, A (General Physics) (USA),* 41(5): 2594-2597 (1 Mar 1990).

The radiative Auger emission (RAE) from 0.94–6.25-MeV/u $_{16}S^{13+}$ (lithiumlike) projectiles excited in collisions with He target atoms has been measured. For these highly stripped ions the intensity of RAE photons relative to $K\alpha$ x-ray emission is enhanced by about a factor of five compared with theoretical calculations and an earlier experimental measurement for S ions with few electron vacancies. The enhancement of RAE for S^{13+} is qualitatively similar to results reported previously for lithiumlike $_{23}V^{20+}$; however, some differences between S and V are evident.

33382 Exact results on light scattered from atoms pumped by coherent and chaotic fields of arbitrary bandwidth. Vemuri, G. (School of Physics, Georgia Institute of Technology, Atlanta, Georgia 30332 (USA)); Roy, R.; Agarwal, G.S. *Physical Review, A (General Physics) (USA),* 41(5): 2749-2755 (1 Mar 1990).

The dynamical behavior of an atom interacting with a coherent field and a chaotic field is studied. Monte Carlo methods are used to integrate the equations describing the dipole moment, population inversion, and two-time correlation functions. The chaotic field can have a finite correlation time. Numerical results for a wide range of the parameters are given. The results depend sensitively on the ratio of the Rabi frequency and the bandwidth of the chaotic field. It is shown how an intense coherent field can suppress the effects of incoherence. The intensity of fluorescence as a function of detuning exhibits narrowing as the strength of the coherent field increases.

33383 Spectroscopic properties of 34 electronic states of zirconium dimer (Zr_2). Balasubramanian, K. (Department of Chemistry, Arizona State University, Tempe, Arizona 85287-1604 (US)); Ravimohan, C. *Journal of Chemical Physics (USA),* 92(6): 3659-3667 (15 Mar 1990). DOE Contract FG02-86ER13558.

State-averaged complete active space multiconfiguration self-consistent field followed by multireference singles + doubles configuration interaction calculations are carried out on low-lying electronic states of zirconium dimer (Zr_2). In addition relativistic configuration interaction calculations are carried out including spin–orbit effects. Thirty-four bound electronic states are found for Zr_2. Three very low-lying states of $^7\Sigma^+_u$, $^3\Sigma^+_u$, and $^1\Sigma^+_g$ symmetries are found as candidates for the ground state. Higher-order correlation effects and extension of basis sets tend to favor the $^1\Sigma^+_g$ state as the ground state of Zr_2 exhibiting approximately a quadruple bond (bond order =3.6). Complete potential energy curves of seven states of Zr_2 are presented. The nature of low-lying electronic states is analyzed through Mulliken populations, natural orbitals and their occupations, spin–orbit effects and weights of various configurations.

33384 Theoretical study of GeH_n, AsH_n, and SeH_n: Ionization energies. Binning, R.C. Jr. (Department of Chemistry, University of Puerto Rico, Rio Piedras, Puerto Rico 00931 (PR)); Curtiss, L.A. *Journal of Chemical Physics (USA),* 92(6): 3688-3692 (15 Mar 1990). DOE Contract W-31109-ENG-38.

Ab initio molecular orbital theory (Moller–Plesset theory to fourth order with a series of extended basis sets) has been used to calculate the total energies of GeH^+_n (n=1–4), AsH^+_n (n=1–3) and SeH^+_n (n=1–2). In combination with previously published results on the neutral hydride molecules, the data are used to derive ionization energies of the neutral species and appearance potentials of the ions with an expected accuracy of ±0.15 eV. Experimental data are reviewed in light of these results. Theoretical predictions of the structures of several cations are discussed including the Jahn–Teller distortion in GeH^+_4.

33385 Time-dependent treatment of scattering: Integral equation approaches using the time-dependent amplitude density. Hoffman, D.K. (Department of Chemistry— Ames Laboratory, Iowa State University, Ames, Iowa (USA)); Sharafeddin, O.; Judson, R.S.; Kouri, D.J. *Journal of Chemical Physics (USA),* 92(7): 4167-4177 (1 Apr 1990). DOE Contract W-7405-ENG-82.

The time-dependent form of the Lippmann–Schwinger integral equation is used as the basis of several new wave packet propagation schemes. These can be formulated in terms of either the

time-dependent wave function or a time-dependent amplitude density. The latter is nonzero only in the region of configuration space for which the potential is nonzero, thereby in principle obviating the necessity of large grids or the use of complex absorbing potentials when resonances cause long collision times (leading, consequently, to long propagation times). Transition amplitudes are obtained in terms of Fourier transforms of the amplitude density from the time to the energy domain. The approach is illustrated by an application to a standard potential scattering model problem where, as in previous studies, the action of the kinetic energy operator is evaluated by fast Fourier transform (FFT) techniques.

6404 Fluid Physics

Refer also to citation(s) 32473, 33607, 33798

33386 (UCRL-ID–103271) **Turbulence modeling in the SHALE code.** Leith, C.E.; Margolin, L.G. Lawrence Livermore National Lab., CA (USA). 7 Mar 1990. 30p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010354. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We have embedded two turbulence models in the two-dimensional fluid code SHALE. A K-ε model, which describes the average mixing due to turbulence, has been modified to include terms relating to compressible flows. In addition, a subgrid-scale K-λ model including stochastic backscatter provides realizations of random, but resolvable structures. We provide a brief description of the two models and also of the initialization of the turbulence in the numerical calculation. We also discuss the details of the algorithms and their implementation in SHALE. We show calculations of the evolution of a shear mixing layer, using the K-λ model. 6 refs., 5 figs., 1 tab.

33387 (UCRL-ID–103611) **COYOTE: A computer program for 2-D reactive flow simulations.** Cloutman, L.D. Lawrence Livermore National Lab., CA (USA). Apr 1990. 35p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-7405-ENG-48. Order Number DE90010349. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We describe the numerical algorithm used in the COYOTE two-dimensional, transient, Eulerian hydrodynamics program for reactive flows. The program has a variety of options that provide capabilities for a wide range of applications, and it is designed to be robust and relatively easy to use while maintaining adequate accuracy and efficiency to solve realistic problems. It is based on the ICE method, and it includes a general species and chemical reaction network for simulating reactive flows. It also includes swirl, turbulence transport models, and a nonuniform mesh capability. We describe several applications of the program. 33 refs., 4 figs.

33388 (UCRL-JC–103579) **Listening to turbulence: An example of scientific audiolization.** Blattner, M.M. (California Univ., Davis, CA (USA)); Greenberg, R.M.; Kamegai, M. Lawrence Livermore National Lab., CA (USA). [1990]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9004187–1: ACM SIGCHI '90 workshop on multimedia and multimodal interface design, Seattle, WA (USA), 1-2 Apr 1990). Order Number DE90010637. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The problem we examine in this paper is: how can one enhance, or even replace, scientific visualization with sound. We call this enhancement scientific audiolization. The problem we selected was that of turbulence in fluid flow. Turbulence is one of the most difficult subjects to understand in physics and engineering. Most fluid flow is turbulent and turbulence is not understood from first principles. For this reason, the visualization of turbulent behavior on the part of fluids is of great use to the scientist. However, there is information associated with turbulence that is not easily visualized. As such, the problem of accurately depicting turbulence lends itself well to a combination of graphic and sonic elements. Sound may also be used to represent data or messages. A message may be displayed in text or voice, but it may also be communicated through a signal we call earcons. One of the goals of this paper is to suggest a model for the simultaneous us of both representational sounds and sound messages (earcons) in a computer/user interface. The audio and graphical representation can be presented to the user in a single multimedia interface (audiovisualization). The first use of sound is the representation turbulent behavior, such as rushing water or the sound of jet engines. The second use of sound is in the transmission of messages pertaining to turbulence. Aspects of turbulence might all be communicated via sound messages, i.e., earcons, such as mathematical singularities, the rate of dissapation of energy, or the handedness of a vortex. 16 refs.

33389 **Rigorous bounds on the fluid permeability: Effect of polydispersivity in grain size.** Torquato, S. (Department of Mechanical Aerospace Engineering, North Carolina State University, Raleigh, North Carolina 27695-7910 (USA)); Lu, B. *Physics of Fluids A (USA)*, 2(4): 487-490 (Apr 1990). DOE Contract FG05-86ER13482.

Rigorous bounds on the fluid permeability (on resistance) of porous media composed of spherical grains with a continuous size distribution are computed. For any finite degree of polydispersivity, scaling the resistance bound by the square of the specific surface (relative to the monodisperse case) yields effectively universal behavior at a fixed sphere volume fraction. A new proposition regarding an exact relationship between the permeability and another effective parameter, the trapping constant associated with diffusion-controlled reactions among traps, is employed to assess the accuracy of the rigorous bound.

33390 **Turbulent energy at accelerating and shocked interfaces.** Mikaelian, K.O. (Lawrence Livermore National Laboratory, University of California, Livermore, California 94550 (USA)). *Physics of Fluids A (USA)*, 2(4): 592-598 (Apr 1990). DOE Contract W-7405-ENG-48.

The turbulent energy generated at accelerating or shocked interfaces between two fluids is calculated. Assuming a linear density profile across the mix region it was found that $E_{turb}/E_{pe}=2.3A^2\%$ for a constant acceleration and $9.3A^2\%$ for a shock, where A is the Atwood number of the two fluids. Somewhat less turbulent energy is generated if density profiles based on self-similar solutions to nonlinear diffusion equations were used. These equations also predict eddy sizes: λ/h=26%–29% and λ/h=16%–18% were found for a constant acceleration and a shock, respectively, where λ is the eddy size controlling the diffusion coefficient and h is the mixing depth into the heavier fluid. The present results were compared with other models and with experiments conducted at AWE.

33391 **Complex cavities: Are two dimensions sufficient for computation?.** Koseff, J.R. (Environmental Fluid Mechanics Laboratory, Department of Civil Engineering, Stanford University, Stanford, California 94305-4020 (USA)); Prasad, A.K.; Perng, C.; Street, R.L. *Physics of Fluids A (USA)*, 2(4): 619-622 (Apr 1990). DOE Contract FG03-84ER13240.

A two-dimensional numerical solution of the flow in a lid-driven cavity with a cutoff is compared with a physical experiment of the same flow. The Reynolds number of the flow is 3200. The results show that whereas the numerical solution is steady, the physical flow is unsteady and oscillates between three different flow modes. The oscillation is ascribed to unsteady three-dimensional structures in the flow.

33392 **Planform selection in rotating convection.** Goldstein, H.F. (Department of Physics, University of California, Berkeley, California 94720 (USA)); Knobloch, E.; Silber, M. *Physics of Fluids A (USA)*, 2(4): 625-627 (Apr 1990).

Three-dimensional convection in a rotating fluid layer is studied near the onset of the steady-state instability using symmetric bifurcation theory. The problem is formulated as a bifurcation problem on a doubly periodic square lattice. Symmetry considerations determine the form of the ordinary differential equations governing the evolution of the marginally stable modes. From the symmetry analysis the relative stability of rolls and squares can be determined. Stable solutions exist only if both patterns bifurcate supercritically, and the one with the largest Nusselt number is the stable one. The theory is illustrated by explicit calculations for idealized boundary conditions, and the bifurcation diagrams given for all values of the Taylor and Prandtl numbers.

33393 Renormalized equations for linear transport in stochastic media. Malvagi, F. (School of Engineering— School of Applied Science, University of California, Los Angeles, Los Angeles, California 90024-1597 (USA)); Pomraning, G.C. *Journal of Mathematical Physics (New York) (USA),* 31(4): 892-900 (Apr 1990).

The master equation is used to obtain a model describing the ensemble-averaged intensity corresponding to linear particle transport in randomly mixed immiscible fluids. An asymptotic limit corresponding to small amounts of opaque fluids admixed with large amounts of transparent fluids is employed to reduce the complexity of the description. In the limit of a single transparent fluid, a renormalized transport equation is obtained, involving an effective source and effective interaction coefficients that account, in a simple way, for the statistical nature of the problem in this asymptotic limit.

33394 New mode of growth of ^{3}He-*B* in supercooled ^{3}He-*A*: Evidence of a spin supercurrent. Boyd, S.T.P. (Condensed Matter— Thermal Physics Group, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)); Swift, G.W. *Physical Review Letters (USA),* 64(8): 894-897 (19 Feb 1990).

We report results of an investigation of the growth of the ^{3}He-*B* phase into the supercooled ^{3}He-*A* phase. The form of the magnetization signal associated with the interface evolved radically with increased hypercooling, suggesting a transition to a new mode of growth. We propose a model based on magnetization transport by a spin supercurrent which accounts for many features of the data.

33395 Dispersion relations for gravity waves in a deep fluid: Second sound in a stormy sea. Larraza, A. (Department of Physics, Naval Postgraduate School, Monterey, California 93943 (USA)); Garrett, S.L.; Putterman, S. *Physical Review, A (General Physics) (USA),* 41(6): 3144-3155 (15 Mar 1990).

We consider the nonlinear processes of interaction between a random field of short deep gravity waves and a deep long gravity wave, as well as the effects of nonlinear interactions among the driven short waves. The interactions are characterized by two types of invariants. First, the short waves possess an adiabatic invariant as regards their interaction with the long waves. Second, a collision between short waves conserves frequency and wave vector. As a consequence of these invariants, extra degrees of freedom appear. This results in a two-fluid description at the surface of the liquid for the mean flow of the long wave plus a distribution of waves. The two-fluid theory implies a spectrum of oscillations of the surface where, besides the usual gravity waves, there exists a surface mode with longitudinal oscillations. The regimes of validity of this hydrodynamic description are discussed, and the solutions for the dispersion relation are also presented. The power spectrum of a stormy sea is derived within the framework of nonlinear wave interactions. Finally, we comment on the relevance of the results to phase-velocity measurements in a wind-wave laboratory experiment, as well as possible experiments to observe the theoretically predicted new mode.

33396 Crossover from singular critical to regular classical thermodynamic behavior of fluids. Chen, Z.Y. (Institute for Physical Science and Technology— University of Maryland, College Park, Maryland 20742 (USA)); Albright, P.C.; Sengers, J.V. *Physical Review, A (General Physics) (USA),* 41(6): 3161-3177 (15 Mar 1990). DOE Contract FG05-88ER13902.

A procedure is presented for constructing a thermodynamic free energy for fluids in the critical region that incorporates the crossover from Ising-like singular behavior near the critical point to regular classical behavior far away from the critical point. The procedure is based on an approximation of the solution of the renormalization-group theory of critical phenomena, modified to include effects from a cutoff wave number for the crossover to the classical limit. As an illustration we show how the procedure can be applied to a truncated classical Landau expansion. The results are compared with experimental thermodynamic-property data for carbon dioxide, steam, and ethylene in the critical region.

33397 A general solution of the molecular Ornstein–Zernike equation for spheres with anisotropic adhesion and electric multipoles. Blum, L. (Department of Physics, P.O. Box 23343, University of Puerto Rico, Rio Piedras, Puerto Rico 00931-3343 (PR)); Cummings, P.T.; Bratko, D. *Journal of Chemical Physics (USA),* 92(6): 3741-3747 (15 Mar 1990).

We present the analytic solution of the molecular Ornstein–Zernike equation for a very general closure in which the direct correlation function is of the form suggested by the mean-spherical approximation for arbitrary multipolar interactions and the total correlation function contains terms that arise in the Percus–Yevick approximation for spheres with anisotropic surface adhesion. In addition to generalizing several earlier analyses of special cases of this closure, the solution presented here contains new simplifying insights that reduce the complexity of the resulting algebraic equations. A special case of the analysis is described to illustrate the method of solution.

6450 High Energy Physics

33398 (SLAC–361) **Physics at the 100 GeV mass scale: Proceedings.** Brennan, E.C. (ed.). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jan 1990. 595p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-8907134–: 17. SLAC summer institute on particle physics: physics at the 100 GeV mass scale, Stanford, CA (USA), 10-21 Jul 1989). Order Number DE90010312. Available from NTIS, PC A25/MF A01; OSTI; INIS; GPO Dep.

This report contains the following papers: heavy quarks–experimental; the theory of heavy flavour production; precision experiments in electroweak interactions; theory of precision electroweak measurements; applications of QCD to hadron-hadron collisions; W^+W^- interactions and the search for the Higgs Boson; electroweak symmetry breaking: Higgs/Whatever; electron-positron storage rings as heavy quark factories; prospects for next-generation e^+e^- linear colliders; current prospects for hadron colliders; hadron colliders beyond the SSC; recent results on weak decays of charmed mesons from the Mark 3 experiment; recent CLEO results on bottom and charm; recent results on B-decays from ARGUE; a review of recent results on the hadron and photoproduction of charm; search for the top quark at UA1; recent results from the UA2 experiment at the CERN $\bar{p}p$ collider; selected preliminary results from CDF; new measurement of the phase difference $\Phi_{00} - \Phi_{\pm}$ in CP–violating K^0 decays; a recent result on CP violation by E731 at Fermilab; rare kaon decay experiments; CP violation; inverse muon decay, neutrino dimuon production, and a search for neutral heavy leptons at the tevatron; first results from MACRO; a superstring theory underview; recent results from TRISTAN ; measurements of the Z boson resonance parameters at SLC; decays of the Z boson; and theory–weak neutral currents and the Z mass after the SLC.

6451 Particle Interactions and Properties - Experimental

Refer also to citation(s) 33434, 33444, 33536

33399 (CEA-CONF–9812) **Spin observables in antip-N elastic scattering.** Bertini, R. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Nucleaire a Moyenne Energie. 1988. 4p. (CONF-880983–: 8. international symposium on high energy spin physics, Minneapolis, MN (USA), 12-17 Sep 1988). Order Number DE90792952. Available from NTIS (US Sales Only), PC A02/MF A01.

The PS198 experiment is described. The preliminary results are discussed and compared with the theoretical predictions of various models. Future perspectives for the measurement of spin observables are presented.

33400 (GSI–90-07) **Report of the Expert Committee 'Intermediate-Energy Physics' 1986-1988/89.** Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Feb 1990. 34p. (In German). Order Number DE90792517. Available from NTIS (US Sales Only), PC A03/MF A01.

The present report concerns work from intermediate-energy physics. They were elaborated by German groups, which were

sponsored by the BMFT in the framework of the collaborational research, and namely in the sponsoring period from January, 1st, 1986 until march, 31st 1989. (orig.).

33401 (GSI–90-07a) **Supplement to the report of the Expert Committee 'Intermediate-Energy Physics' 1986-1988/89.** Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Feb 1990. 48p. (In German). Order Number DE90792519. Available from NTIS (US Sales Only), PC A03/MF A01.

In the supplement to the scientitic report of the sponsoring project of the Federal Ministery for Research and Technology 'Intermediate-Energy Physics' the publications are collected, which have come out in the three years of the sponsoring in the single projects. Essentially only journal articles were taken up, in order to keep the extent of this list surveyable. On the taking up of the manifold of dissertations, diploma theses, and talks generally was abandoned. (orig.).

33402 (Juel-Spez–535) **The reaction anti pp → anti ΛΛ 92 MeV above the reaction threshold.** Sehl, G. Forschungszentrum Juelich GmbH (Germany, F.R.). Inst. fuer Kernphysik; Bonn Univ. (Germany, F.R.). Dec 1989. 147p. (In German). Order Number DE90792294. Available from NTIS (US Sales Only), PC A07/MF A01.

The reaction anti pp→anti ΛΛ has been studied at an excess energy of 92 MeV (1.695 GeV/c anti p-momentum) at the CERN Low Energy Antiproton Ring (LEAR). Based on a high statistic of 11362 analyzed anti ΛΛ-events accurate results for Λ(anti Λ)-life time, total and differential cross sections, polarization and spin correlations are presented. A comparison of the asymmetry parameters and the mean life times of Λ and anti Λ gives new lower limits for the validity of the CP- and the CPT-invariance in the Λ-system. For the singlet fraction S = -0.032 ± 0.030 was measured: the anti ΛΛ are produced in a pure triplet state. (orig.).

33403 (KEK-PR–89-1, pp. 8-26) **Kaon rare decays.** Sato, Takahiro (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). 1989. (CONF-8810465–: 3. workshop on elementary-particle picture of the universe, Fujiyoshida (Japan), 17-19 Oct 1988). In *Proceedings of the third workshop on elementary-particle picture of the universe.* Order Number DE90741340. Available from NTIS (US Sales Only), PC A13/MF A01.

The decay $K^+ \rightarrow \pi^+ \nu \nu$-bar is a very interesting process. There is a reliable higher order calculation which assumes three generations. B-B-bar mixing, B-lifetime and the top quark mass give strong restrictions on the branching ratio of the decay. Any conflict with the calculation or the restrictions given by B experiments will suggest new physics in the form of extra generation or new types of particles or interactions. The branching ratio of $K_L \rightarrow \mu \mu$ has already been determined. The muon polarization is expected to be zero in the standard model. If non-zero polarization is observed, it represents an additional CP violation. Lepton flavor violating interactions like $K_L \rightarrow \mu e$ or $K^+ \rightarrow \pi^+ \mu e$ are strictly forbidden in the standard model with massless neutrinos. However, there are some models in which flavor violations are mediated by horizontal gauge bosons, leptoquarks or supersymmetric particles. Searches for these rate decays to the order of 10^{-10} would deal with the mass scale of the order of 100 TeV, but this mass scale can not be reached by any of the existing or planned accelerators. The process $K_L \rightarrow \pi^0 e^+ e^-$ is also an interesting decay mode. The single photon intermediate state of this rare decay is violating the CP conservation. Although the two photon intermediate state of the decay conserves CP, the search for this rare decay would give additional information for CP nonconservation. (N.K.).

33404 (KEK-PR–89-1, pp. 220-233) **Present status of $\beta\beta$ decay measurements.** Okada, K. (Osaka Univ., Toyonaka (Japan). Lab. of Nuclear Studies). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). 1989. (CONF-8810465–: 3. workshop on elementary-particle picture of the universe, Fujiyoshida (Japan), 17-19 Oct 1988). In *Proceedings of the third workshop on elementary-particle picture of the universe.* Order Number DE90741340. Available from NTIS (US Sales Only), PC A13/MF A01.

Questions whether the neutrino is a Majorana particle or a Dirac particle and whether massive or massless are quite important in view of the grand unification of interactions and the galactic dark matter. The most sensitive probe to study the massive Majorana neutrino is a neutrinoless double beta decay ($O\nu\ \beta\ \beta$). The double beta decays can be seen when a given isotope0is unstable energetically in the isobar chain but is stable against the single β^- and β^+ decays. There are 35 $\beta^-\beta^-$ and 40 $\beta^+\beta^+$ isotopes. The double beta decay experiments for the last decade have been mainly focussed on ^{76}Ge, because the ^{76}Ge$\beta\ \beta$ isotope is contained in a natural Ge detector with 7.8% abundance. Thus the $\beta\ \beta$ events are almost fully detected by the Ge detector. The $\beta\ \beta$ counter experiments for nuclei other than ^{76}Ge are aimed to observe clearly the 2ν mode, which should occur necessarily because of the absence of violation of any conservation laws and symmetries. The $\beta\ \beta$ sources with large nuclear sensitivity are chosen. Since the ^{82}Se and ^{100}Mo isotopes have large $Q_{\beta\beta}$ values of about 3 MeV, they are the best candidates. In order to explore a possible finite Majorana neutrino mass in the range of 0.1-1 eV and a finite right handed weak current in the range around 10^{-6}, new large scale detector systems should satisfy some requirementrs for large aystem sensitivity and mode selectivity. The ^{100}Mo is one of the best candidates to serve for the search for $O\nu\ \beta\ \beta$ decays. (N.K.).

33405 (KURRI-TR–318, pp. 56-61) **Observation of the delayed proton decay by means of a recoil mass separator.** Hatori, Satoshi (Kyoto Univ. (Japan). Faculty of Science). Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. May 1989. (In Japanese). (CONF-8901177–: 1. specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor, Kumatori (Japan), 24-25 Jan 1989). In *Proceedings of the 1st specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor.* Order Number DE90741373. Available from NTIS (US Sales Only), PC A06/MF A01.

The report addresses the observation of the beta-delayed proton decay of Tz=-2 nuclei by using a recoil mass separator. Development of a measuring technique and results obtained so far are described. Various improvements are made in the recoil mass separator to solve major problems arising from the fact that the cross section of the (^{3}He, 3N) reaction is small. The improvements are mostly intended for increased yield and S/N ratio. To increase the yield, a special optical system is developed for the recoil mass separator and analysis is made of the cycle of beam switching and the inclination of the target. The optical system developed has a detecting solid angle of 3msr and an energy receiving width of ±10 percent. To increase the S/N ratio, an ion-passing detector is developed and analysis is made of the times and positions of ion events and decay particle events by means of the combination of the ion-passing detector and a position-sensitive detector. A beta counter is used in combination to decrease the background. The report also presents some data on the energy spectrum of beta-delayed protons from ^{25}Si, ^{24}Si and ^{17}Ne. (N.K.).

33406 (LBL–28672) **Two-photon physics.** Cahn, R.N. Lawrence Berkeley Lab., CA (USA). Mar 1990. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8908142–6: 14. international symposium on lepton and photon interactions at high energies, Stanford, CA (USA), 7-12 Aug 1989). Order Number DE90011216. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Recent experimental results in two-photon physics are reviewed. Possibilities for future experimentation at high $\gamma\gamma$ collision energies are discussed. 95 refs., 12 figs., 7 tabs.

33407 (LBL–28736) **Elastic scattering and total cross sections.** Cahn, R.N. Lawrence Berkeley Lab., CA (USA). Mar 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-8905208–4: 3. international conference on elastic and diffractive scattering, Evanston, IL (USA), 2-6 May 1989). Order Number DE90011217. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This report discusses concepts of elastic scattering and cross sections of proton-proton interactions. (LSP)

33408 (MPI-PAE/Exp.El.–214/89) **Prompt leptons from the decays of heavy quarks in the e^+e^- annihilation at energies of**

35 and 43 GeV. Kroha, H. Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik; Technische Univ. Muenchen, Garching (Germany, F.R.). Fakultaet fuer Physik. Dec 1989. 265p. (In German). Order Number DE90792264. Available from NTIS (US Sales Only), PC A12/MF A01.

Production and decays of heavy quarks in e^+e^- annihilations have been investigated with te CELLO detector in the energy range from 35 GeV up to the highest PETRA energies of 46.78 GeV. The semileptonic branching ratios and the charge asymmetries of b and c quarks, at $\sqrt{s}$=35 and 43 GeV have been simultaneously measured using, in addition to the lepton transverse momentum, correlated jet variables for quark flavour separation. We determined the charge asymmetries to be $A_{FB}{}^b$=-(22.2 ± 8.1)%, $A_{FB}{}^c$=-(12.9 ± 8.8)% at 35 GeV and $A_{FB}{}^b$=-(49.1 ± 16.5)%, $A_{FB}{}^c$=+(7.7 ± 14.0)% at 43 GeV, respectively. Taking B^0anti B^0 mixing into account, the combined measurements result in values for the axial vector couplings of the heavy quarks of a_c=+(0.28 ± 0.45) and a_b=-(1.26 ± 0.38) which are in good agreement with the standard model predictions of a_c=+1 and a_b=-1, respectively. We also measured the banti b and canti c production cross section at both centre of mass energies and give an upper limit for the B^0 meson mixing parameters of χ_l<0.16 (90% C.L.) and lower limits in the 1-2 TeV range for the scale of a possible common electron-heavy quark compositeness from the measured asymmetries. Up to the maximum PETRA energies, we find no indication for new phenomena in the production of hadronic events with isolated leptons. (orig.).

33409 (PCCF-T–88-13) **Inclusive results at 90°, at I.S.R., favourable to a diquark under-structure of the proton, and estimations of quantum chromodynamics.** Mahrousseh, A. Clermont-Ferrand-2 Univ., 63 - Aubiere (France). 1988. 200p. (In French). Order Number DE90792884. Available from NTIS (US Sales Only), PC A09/MF A01.

Inclusive measurements of protons and antiprotons, at ninety degrees, generated in proton-antiproton or proton-proton interactions, give different information. After an improvement in the particles' identification as a result of the association of silicagel detectors and the time of flight, the following results were achieved: the global test of the CR and CP invariances in strong proton-antiproton, and the need of a proton scalar diquark under-structure to explain the anomalous level of protons, either in agreement to other similar experiments or very different. The name of covalon or coquark for this bound state is proposed. In ultra-relativistic heavy ions interactions, the covalons' suppression would be a new and strong identification sign for quarks and gluons plasma.

33410 (SLAC-PUB–5236) **A summary of the results from LASS [Large Aperture Superconducting Solenoid] and the future of strange quake spectroscopy.** Aston, D.; Bienz, T.; Bird, T.; Dunwoodie, W.; Johnson, W.; Kunz, P.; Kwon, Y.; Leith, D.; Levinson, L.; Ratcliff, B. Stanford Linear Accelerator Center, Menlo Park, CA (USA). 2 May 1990. 19p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract AC03-76SF00515. Grant PHY82-09144;Grant PHY85-13808. (CONF-900135–5: 15. general meeting of the Division of Particles and Fields of the American Physical Society, Houston, TX (USA), 3-6 Jan 1990). Order Number DE90010309. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A brief summary is presented of results pertinent to quark spectroscopy derived from high statistics data on K^-p interactions obtained with the LASS spectrometer at SLAC. The present status of strange meson spectroscopy is briefly reviewed, and the impact of the proposed KAON Factory on the future of the subject considered. 36 refs., 24 figs.

33411 ***A* dependence of J/ψ production in π^--nucleus collisions at 530 GeV/*c*.** Kartik, S.; Crittenden, R.; De, K.; Dzierba, A.; Li, R.; Markham, S.; Marshall, T.; Martin, J.; Smith, P.; Sulanke, T. *Physical Review, D (Particles Fields) (USA),* 41(1): 1-8 (1 Jan 1990).

The *A* dependence of the cross section for J/ψ production was measured in the Feynman-*x* region $0.1 \le x_F \le 0.8$ with a 530-GeV/*c* π^- beam. Thick targets of C, Al, Cu, and Pb were employed. Using the cross-section parametrization $\sigma = \sigma_0 A^\alpha$, we find $\alpha = 0.85 \pm 0.06$. No statistically significant dependence of α on either x_F or transverse momentum p_t is observed.

33412 **Measurement of the two-photon width of the η and η' mesons.** Roe, N.A. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94309 (US)); Bartha, G.; Burke, D.L.; Garbincius, P.; Hawkins, C.A.; Jonker, M.J.; Steele, T.R.; Johnson, A.S.; Whitaker, J.S.; Wilson, R.J. *Physical Review, D (Particles Fields) (USA),* 41(1): 17-21 (1 Jan 1990). DOE Contract AC03-76SF00515;AC02-86ER40284;AC02-76ER03071.

Formation of the η and η' mesons in two-photon interactions has been observed with the ASP detector at the SLAC e^+e^- storage ring PEP ($\sqrt{s}$=29 GeV). In a data sample of 108 pb^{-1}, a total of 2287 η and 547 η' events have been detected in the $\gamma\gamma$ decay mode. The two-photon widths are determined to be $\Gamma_{\gamma\gamma}(\eta) = 0.490 \pm 0.010 \pm 0.048$ keV and $\Gamma_{\gamma\gamma}(\eta') = 4.96 \pm 0.23 \pm 0.72$ keV. The SU(3) pseudoscalar mixing angle deduced from these values is $\theta_p = -19.8\ ^\circ \pm 2.2\ ^\circ$.

33413 **Measurement of D^* production in jets from $\bar{p}p$ collisions at $\sqrt{s}$ =1.8 TeV.** Abe, F.; Amidei, D.; Apollinari, G.; Ascoli, G.; Atac, M.; Auchincloss, P.; Baden, A.R.; Barbaro-Galtieri, A.; Barnes, V.E.; Bedeschi, F. *Physical Review Letters (USA),* 64(4): 348-352 (22 Jan 1990).

The production rate of charged D^* mesons in jets has been measured in 1.8-TeV $\bar{p}p$ collisions at the Fermilab Tevatron with the Collider Detector at Fermilab. In a sample of approximately 32 300 jets with a mean transverse energy of 47 GeV obtained from an exposure of 21.1 nb^{-1}, a signal corresponding to $25.0 \pm 7.5(\text{stat}) \pm 2.0(\text{syst})$ $D^{*\pm} \to K^{\mp}\pi^{\pm}\pi^{\pm}$ events is seen above background. This corresponds to a ratio $N(D^{*+}+D^{*-})/N(\text{jet}) = 0.10 \pm 0.03 \pm 0.03$ for D^* mesons with fractional momentum z greater than 0.1.

33414 **Branching ratio and asymmetry for $\Xi^0 \to \Lambda\gamma$.** James, C. (School of Physics— School of Astronomy, University of Minnesota, Minneapolis, Minnesota 55455 (USA)); Heller, K.; Border, P.; Dworkin, J.; Overseth, O.E.; Rameika, R.; Valenti, G.; Handler, R.; Lundberg, B.; Pondrom, L. *Physical Review Letters (USA),* 64(8): 843-846 (19 Feb 1990).

We have measured the branching ratio $\Gamma(\Xi^0 \to \Lambda\gamma)/\Gamma(\Xi^0 \to \Lambda\pi^0)$ to be $[1.06 \pm 0.12(\text{stat}) \pm 0.11(\text{syst})] \times 10^{-3}$. In 670 000 $\Lambda\gamma$ candidates we found 116±13 $\Xi^0 \to \Lambda\gamma$ decays (background subtracted). These compare with 29 510 $\Xi^0 \to \Lambda\pi^0$ events reconstructed from the $\Lambda\gamma\gamma$ sample. Monte Carlo studies gave the relative acceptances for the two processes. The helicity of the Λ yielded the product of asymmetry parameters $\alpha(\Lambda \to p\pi^-)\alpha(\Xi^0 \to \Lambda\gamma) = 0.27 \pm 0.28$, which implies $\alpha(\Xi^0 \to \Lambda\gamma) = 0.43 \pm 0.44$, where the uncertainty is all statistical.

33415 **Search for long-lived massive neutrinos in *Z* decays.** Jung, C.K.; Van Kooten, R.; Abrams, G.S.; Adolphsen, C.E.; Averill, D.; Ballam, J.; Barish, B.C.; Barklow, T.; Barnett, B.A.; Bartelt, J. *Physical Review Letters (USA),* 64(10): 1091-1094 (5 Mar 1990). DOE Contract AC02-84ER40125;AC03-76SF00098;AC02-76ER01112.

We search for events in the Mark II detector at SLAC Linear Collider with the topology of a *Z* boson decaying into a pair of long-lived massive particles. No events that are consistent with the search hypothesis are found. Interpreting the long-lived particle as a sequential Dirac neutrino ν_4 of the fourth generation, we exclude at the 95% confidence level a significant range of mixing-matrix elements of ν_4 to other-generation neutrinos for a ν_4 mass from 10 to 43 GeV/c^2.

33416 **Measurement of the B^0-meson lifetime.** Wagner, S.R.; Hinshaw, D.A.; Ong, R.A.; Snyder, A.; Abrams, G.; Adolphsen, C.E.; Akerlof, C.; Alexander, J.P.; Alvarez, M.; Amidei, D. *Physical Review Letters (USA),* 64(10): 1095-1098 (5 Mar 1990). DOE Contract AC03-83ER40103;AC02-84ER40125;AC03-76SF00098.

We report a measurement of the lifetime of the B^0 meson based upon 29-GeV e^+e^- annihilation data taken with the Mark II detector at the SLAC storage ring PEP. The B^0 mesons are tagged by their decays into $D^{*-}e^+\nu$ and $D^{*-}\mu^+\nu$, where the D^{*-} is tagged by its decay into $\pi^-\bar{D}^0$. We reconstruct the decay vertices of 15 B^0-meson candidates and measure the B^0 lifetime to be $1.20^{+0.52}_{-0.36}{}^{+0.16}_{0.14}$ psec.

33417 Quasielastic electron scattering and Coulomb sum rule in ^{4}He. Reden, K.F. von (Department of Physics, University of Pittsburgh, Pittsburgh, Pennsylvania 15260 (USA)); Alcorn, C.; Dytman, S.A.; Lowry, B.; Quinn, B.P.; Beck, D.H.; Bernstein, A.M.; Blomqvist, K.I.; Dodson, G.; Dow, K.A. *Physical Review, C (Nuclear Physics) (USA),* 41(3): 1084-1094 (Mar 1990). DOE Contract AC02-76ER03069.

Double differential cross sections for inelastic electron scattering from ^{4}He have been measured at bombarding energies between 279 and 725 MeV. The longitudinal and transverse response functions were obtained for constant momentum transfer between 300 and 500 MeV/*c*. Plane-wave impulse approximation calculations overestimate the longitudinal response and produce fair agreement with the transverse part. The Coulomb sum is determined and compared with exact calculations. Within the experimental error the data exhaust the sum rule; this provides a first measurement of ground-state correlations.

33418 *A* dependence of highly inelastic *p*-nucleus collisions. Sambamurti, A.; Blessing, S.; Crittenden, R.; Draper, P.; Dzierba, A.; Heinz, R.; Krider, J.; Marshall, T.; Martin, J.; Smith, P. Fermilab E557/E672 Collaboration. *Physical Review, D (Particles Fields) (USA),* 41(5): 1371-1383 (1 Mar 1990).

The nuclear (*A*) dependence of the event structure in the central and forward (projectile fragmentation) regions has been studied for highly inelastic proton-nucleus (*pA*) collisions at an incident momentum of 800 GeV/*c*. Events with high values of transverse energy (E_t) were selected using the large-acceptance Fermilab multiparticle spectrometer. The multiplicity distributions and energy flows in different regions of phase space are presented for six nuclear targets: H, Be, C, Al, Cu, and Pb. The event structure for highly inelastic *pA* collisions is strongly dependent on the transverse energy observed in the central region. However at a fixed E_t, there is only a weak nuclear dependence of event structure in the central and forward fragmentation regions. This observation is consistent with a thermodynamical description of inelastic *pA* interactions and suggests that the observed E_t is a good measure of the inelasticity of the reaction. The nuclear dependence of event structure on the particle density and the energy in the forward fragmentation region is also discussed. In contrast with E_t as a variable, the particle density and the forward missing energy provide measures of event inelasticity that are *A* dependent.

33419 Upper limits on $D^{\pm}$ and $B^{\pm}$ decays to two leptons plus $\pi^{\pm}$ or $K^{\pm}$. Weir, A.J.; Klein, S.R.; Abrams, G.; Adolphsen, C.E.; Akerlof, C.; Alexander, J.P.; Alvarez, M.; Amidei, D.; Baden, A.R.; Ballam, J. *Physical Review, D (Particles Fields) (USA),* 41(5): 1384-1388 (1 Mar 1990). DOE Contract AC02-84ER40125;AC03-76SF00515;AC03-76SF00098.

Data taken by the Mark II detector at the SLAC e^+e^- storage ring PEP was used to search for exclusive decays of $D^{\pm}$ and $B^{\pm}$ mesons into two charged leptons plus a charged pion or kaon. All possible charge and lepton combinations consistent with charge conservation were considered and no evidence for any signals was found. We obtain upper limits for the various branching ratios ranging from 2.5×10^{-3} to 9.2×10^{-3}, at a 90% confidence level. Some of these limits can be used to constrain leptoquark masses in various models.

33420 Measurement of the branching ratio for the decay $\tau^-\to e^-\bar{\nu}_e\nu_\tau$. Abachi, S. (Argonne National Laboratory, Argonne, Illinois 60439 (USA)); Derrick, M.; Kooijman, P.; Musgrave, B.; Price, L.; Repond, J.; Sugano, K.; Blockus, D.; Brabson, B.; Brom, J. *Physical Review, D (Particles Fields) (USA),* 41(5): 1414-1424 (1 Mar 1990). DOE Contract W-31109-ENG-38.

This paper reports a new measurement of the branching ratio for the decay $\tau^-\to e^-\bar{\nu}_e\nu_\tau$. The data were taken with the High Resolution Spectrometer at the SLAC e^+e^- colliding-beam facility PEP, operating at $\sqrt{s}$=29 GeV. The result $B(\tau^-\to e^-\bar{\nu}_e\nu_\tau)=(17.0\pm0.5\pm0.5)\%$, together with our measurements of the lifetime and the topological branching fractions of the τ lepton are compared with theoretical expectations.

33421 Weak-boson production by charm quarks. Hagiwara, K. (Department of Physics, University of Durham, DH1 3LE, Durham, England (GB)— Department of Physics, University of Wisconsin, Madison, Wisconsin 53706 (USA)); Halzen, F.; Kim, C.S. *Physical Review, D (Particles Fields) (USA),* 41(5): 1471-1475 (1 Mar 1990). DOE Contract AC02-76ER00881.

We propose a method to extract the charm structure function of the nucleon $c(x,Q^2=m_W^2)$ from measurements of the rapidity distribution of $W^{\pm}$ and Z in $p\bar{p}$ collisions. The production of weak intermediate bosons via charm occurs at the few percent level at the Fermilab Tevatron and has in particular a strong influence on the important measurement of the ratio of W and Z events as $c\bar{s}\to W$ is expected to be much larger than $c\bar{c}\to Z$.

33422 Probing the $WW\gamma$ vertex at the Fermilab Tevatron Collider. Baur, U. (CERN, Geneva, Switzerland (CH)); Berger, E.L. *Physical Review, D (Particles Fields) (USA),* 41(5): 1476-1488 (1 Mar 1990). DOE Contract W-31109-ENG-38.

A detailed analysis of $W\gamma$ production and radiative W decays at the Fermilab Tevatron is presented for general $WW\gamma$ couplings. Possibilities to test the gauge structure of the $WW\gamma$ vertex are explored. At the Tevatron, for an integrated luminosity of 100 pb^{-1}, the $WW\gamma$ vertex can be measured with 25–40% accuracy in $W\gamma$ production. The limits which can be obtained from radiative W decays are found to be significantly weaker.

33423 Study of the doubly radiative decay $J/\psi\to\gamma\gamma\rho^0$. Coffman, D.; DeJongh, F.; Dubois, G.; Eigen, G.; Hauser, J.; Hitlin, D.G.; Matthews, C.G.; Mincer, A.; Richman, J.D.; Wisniewski, W.J. The Mark III Collaboration. *Physical Review, D (Particles Fields) (USA),* 41(5): 1410-1413 (1 Mar 1990). DOE Contract AC03-76SF00515;AC02-76ER01195;AC03-81ER40050;AM04-

We present a study of the decay sequence $J/\psi\to\gamma X$, $X\to\gamma\rho^0$, $\rho^0\to\pi^+\pi^-$, based on 5.8×10^6 produced J/ψ collected by the Mark III detector at the SLAC storage ring SPEAR. In the $\gamma\rho^0$ mass spectrum, we find two peaks with masses and widths consistent with the axial-vector mesons $f_1(1285)$ and $f_1(1420)$ that have recently been observed in two-photon collisions. Fits to the angular distributions confirm that the first peak is an axial-vector state, but are unable to distinguish between the $f_1(1420)$ or the pseudoscalar $\eta(1430)$ for the high-mass peak. Product branching fractions for both objects are presented.

33424 Search for a light Higgs boson at the Fermilab Tevatron proton-antiproton collider. Abe, F.; Amidei, D.; Apollinari, G.; Atac, M.; Auchincloss, P.; Baden, A.R.; Bamberger, A.; Barbaro-Galtieri, A.; Barnes, V.E.; Bedeschi, F. *Physical Review, D (Particles Fields) (USA),* 41(5): 1717-1721 (1 Mar 1990).

We have searched for a light standard-model Higgs boson produced in association with an intermediate vector boson at the Fermilab proton-antiproton collider operating at a center-of-mass energy of 1.8 TeV. The search was made by looking for an excess of isolated high-transverse-momentum charged-track pairs in W and Z events. A Higgs boson with a mass m_H in the intervals $2m_\mu<m_H<818$ MeV/c^2 and 846 MeV/$c^2<m_H<2m_K$ is excluded at 90% C.L.

33425 Two-jet invariant-mass distribution at $\sqrt{s}$ ≈1.8 TeV. Abe, F.; Amidei, D.; Apollinari, G.; Ascoli, G.; Atac, M.; Auchincloss, P.; Baden, A.R.; Barbaro-Galtieri, A.; Barnes, V.E.; Bedeschi, F. *Physical Review, D (Particles Fields) (USA),* 41(5): 1722-1725 (1 Mar 1990).

We present the dijet invariant-mass distribution in the region between 60 and 500 GeV, measured in 1.8-TeV $\bar{p}p$ collisions in the Collider Detector at Fermilab. Jets are restricted to the pseudorapidity interval $|\eta|<0.7$. Data are compared with QCD calculations; axigluons are excluded with 95% confidence in the region $120<M_A<210$ GeV for axigluon width $\Gamma_A=N\alpha_s M_A/6$, with N=5.

6452 Particle Interactions and Properties - Theoretical

Refer also to citation(s) 32832, 33343, 33406, 33407, 33422, 33481, 33482, 33488, 33494, 33505, 33516, 33519, 33525, 33566, 33712

33426 (BONN-IR-89-43) **The calculation of the quark distribution amplitude of the $\Delta^{3/2+}(1232)$ respectively the**

$\Delta^{1/2-}(1600)$ by means of the QCD sum rules for the determination of the N→Δ transition form factor at $Q^2 \simeq 10$ GeV^2. Bonekamp, J. Bonn Univ. (Germany, F.R.). Physikalisches Inst.; Bonn Univ. (Germany, F.R.). Mathematisch-Naturwissenschaftliche Fakultaet. Jul 1989. 175p. (In German). Order Number DE90792258. Available from NTIS (US Sales Only), PC A08/MF A01.

The QCD sum rule approach of Chernyak and Zhitnitsky for calculating the quark distribution amplitudes is applied to the lowest lying nucleon resonance of spin 3/2 and positive parity, namely the Δ(1232). With the help of an especially developed REDUCE computer program package the sum rules for the first few moments of the wavefunction are calculated. It is found that no fiducial region exists, where the sum rules can be saturated such that the amount of the nonperturbative and continuum contributions are acceptable. A detailed analysis shows that the reasons for this defect are the spin-mixing on the light-cone and the canonical choice of the baryonic currents in connection with their correlation function. We show however that with the considered currents the sum rules can be saturated accurately by a dominating baryon resonance with a mass around 1600 MeV. The resulting quark distribution amplitude of this resonance, which is identified as the Δ(1600) with 1/2 and negative parity, is compatible with its asymptotic form and shows no asymmetry in the quark momenta. Its magnetic transition form factor at momentum transfer of several GeV is calculated refering to the perturbative QCD results of Carlson and Poor. (orig.).

33427 (BONN-IR-90-05) **Studies on the separation between higher-twist and minimum-twist in the photoproduction experiment WA69 at the CERN-OMEGA spectrometer.** Kingler, J. Bonn Univ. (Germany, F.R.). Physikalisches Inst.; Bonn Univ. (Germany, F.R.). Mathematisch-Naturwissenschaftliche Fakultaet. Jan 1990. 92p. (In German). Order Number DE90792220. Available from NTIS (US Sales Only), PC A05/MF A01.

A Lund type Monte Carlo program (LUCIFER) is used to describe in perturbative QCD the pointlike component of the photon interacting on a hydrogen target. Kinematical and topological variables are developed to enhance higher twist events on the lowest order minimum twist background. The emphasis is laid on $\pi^{\pm}$, $K^{\pm}$ higher twist mesons. (orig.).

33428 (CBPF-NF-026/89) **Hadron production in a fireball radiation model for electron-positron collisions.** Bediaga, I. (Turin Univ. (Italy). Dipt. di Fisica Teorica); Joffily, S.; Predazzi, E. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 28p. Order Number DE90627506. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A model of fireball radiated e^+e^- collisions and radiating in turn other fireballs (i.e. hadrons) is shown to describe well the large bulk of particle production (multiplicities, inclusive distributions, fractions as functions of momenta). One adjustable parameter is used for each kind of hadron emitted (minus an overall constraint). When considered as a process in the mean, the scheme is shown to be equivalent to a sequential decay where the only assumption made is that at each a particle is emitted with an energy proportional to that of the decaying parent and the proportionality factor turns out to be, numerically, nothing but the running coupling constant of QCD. The consequence of this scheme are investigated. (author).

33429 (CBPF-NF-032/89) **Physical properties of the chiral quantum baryon.** Mignaco, A.J. (Universidade Federal, Rio de Janeiro, RJ (Brazil). Inst. de Fisica); Wulck, S. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 44p. Order Number DE90627521. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

It is presented an account to understand the quantum chiral baryon, which a stable chiral soliton with baryon number one obtained after first quantization by collective coordinates. Starting from the exact series solution to the non-linear sigma model with the hedge-hog configuration, the values of several physical quantities (mass, axial weak coupling, gyromagnetic ratios and radii) as a function of the order of Pade approximants used as approximanted representations of the solution, are calculated. It turns out that consistent results may be obtained, but a better approximation should be developed. (author).

33430 (CBPF-NF-044/89) **Higher order equations of motion.** Bollini, C.G.; Giambiagi, J.J. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 15p. Order Number DE90627522. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The possibility that the motion of elementary particles be described by higher order differential equations induced by supersymmetry in higher dimensional space-time is discussed. The specific example of six dimensions writing the corresponding Lagrangian and equations of motion, is presented. (author).

33431 (CEA-CONF-9854) **Cut-off and effective meson field theory.** Ripka, G. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (FR). Service de Physique Theorique); Jaminon, M.; Stassart, P. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Theorique. 1989. 2p. (CONF-8902107--: School on nuclear matter and heavy ion collisions, Les Houches (France), 7-16 Feb 1989). Order Number DE90792994. Available from NTIS (US Sales Only), PC A02/MF A01.

The behavior of the constituent quark mass, in the vacuum, is investigated. The regularization scheme and the value of the corresponding cut-off are chosen. Two branches are observed in the ϕ_0 (λ) curve. The results show a minimum value of the cut-off, under which no constituent quark mass can be obtained. This value is close to 300MeV in the soft regularization scheme. The investigation of the nuclear matter saturation with respect to the cut-off definition, is suggested.

33432 (CNIC-00269) **A consistent analysis for the quark condensate $<\phi\ \phi>$ in QCD.** Huang Zheng (Academia Sinica, Beijing, BJ (China). Inst. of High Energy Physics); Huang Tao. China Nuclear Information Centre, Beijing, BJ (China). Aug 1988. 11p. (BIHEP-0009). Order Number DE90627496. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The dynamical symmetry breaking in QCD is analysed based on the vacuum condensates. A self-consistent equation for the quark condensate $(\phi\ \phi)$ is derived. A nontrivial solution for $(\phi\ \phi) \neq 0$ is given in terms of the QCD scale parameter A.

33433 (DOE/ER/13065-568) **Precise extractions of the x and Q^2 dependence of $R = \sigma_L/\sigma_T$, F_{2p}, F_{2d}, and $F_{2n}/_{2p}$ from a combined analysis of SLAC [Stanford Linear Accelerator Center] deep inelastic electron scattering experiments.** Whitlow, L.W. (Stanford Univ., CA (USA)); Rock, S.; Bodek, A.; Dasu, S.; Riodan, E.M. Rochester Univ., NY (USA). Dept. of Physics and Astronomy. 3 May 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76ER13065. (UR-1101;CONF-9003161-1: 25. Rencontres de Moriond on QCD and hadronic interactions conference, Les Arcs (France), Mar 1990). Order Number DE90011013. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We report on a precise study of the x and Q_2 dependence of the proton, deuteron and neutron structure functions. In particular $R = \sigma_L/\sigma_T$, F_{2_p}, F_{2_d}, and the ratio F_{2_d}/F_{2_p} were extracted in a combined analysis of SLAC deep inelastic electron scattering experiments. Data from eight experiments were radiatively corrected with a new improved radiative correction formalism, and all experiments were normalized to the precise data of SLAC E140, thus yielding a single coherent data set. We find that $R_p = R_d$ as expected from QCD. The results for R are somewhat larger than the prediction of QCD with target mass effects, thus indicating the existence of additional dynamic higher twist effects. Using both SLAC and CERN data, we obtained a parametrization of R in the range $0.5 < Q^2 < 200$ GeV/c^2 and $0.1 < x < 0.86$. This fit in conjunction with the normalized hydrogen and deuterium cross sections was used to extract precise values of F_2. These data provide a constraint at low Q^2 for high Q^2 muon and neutrino experiments. A study of the Q^2 dependence of the ratio of deuteron and proton structure functions shows a slope which is consistent with QCD and explains the difference in this ratio between SLAC and CERN experiments. 7 figs.

33434 (DOE/ER/40315-T1) **Hadron physics: Summary papers on hadron physics for the NSAC long range plan.** Carnegie-Mellon Univ., Pittsburgh, PA (USA). Dept. of Physics. 5 Jul 1989. 59p. Sponsored by U.S. DOE Energy Research. DOE

Contract FG02-87ER40315. Order Number DE90007227. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

This paper discusses: Hadronic Form Factors; Structure Functions and Parton Densities; Hadron Spectroscopy; Hadron-Hadron Interactions; and Symmetries and Hadronic Physics.

33435 (IC–89/313) **Heavy quarkonium production close to neutral gauge E_6 bosons in e^+e^- annihilation.** Pankov, A.A. International Centre for Theoretical Physics, Trieste (Italy). Oct 1989. 38p. Order Number DE90627507. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A study is made of the interference in the e^+e^- annihilation of the strongly mass-degenerate states of a vector resonance $V_Q=^3S_1$(QQ-bar) (where Q is t-quark, or fourth generation down-type quark b' with $e_{b'}$ = -1/3 or weak isosinglet h-quark expected in superstring models with e_h = -1/3) and either the standard neutral gauge boson Z or a new, heavy neutral Z' boson predicted by many superstring-inspired models based on E_6. In this paper we analyze the main decay models of these systems, the total cross section of $e^+e^- \rightarrow \mu^+\mu^-$ process and various asymmetries and find quite different behaviour of these observables for the case of t-quark, fourth-generation and E_6 exotic quarkonia both at M_V approx M_Z or $M_{Z'}$. These observables can be easily used to distinguish these three possible quarkonium states. (author). 19 refs, 8 figs.

33436 (IC–89/380) **QED corrected extra Z boson effects at e^+e^- colliders.** Leike, A. (International Centre for Theoretical Physics, Trieste (Italy)); Riemann, T.; Sachwitz, M. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 16p. Order Number DE90627508. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The additional QED corrections due to the exchange of a hypothetical Z' boson together with photon and Z boson exchange are derived for e^+e^- annihilation into fermion pairs. Numerical applications have been considered for E_6-generated extra Z bosons. Though being large at higher energy, Z' produced QED corrections are almost negligible at TRISTAN and LEP1 energies. (author). 23 refs, 2 figs, 1 tab.

33437 (IC–89/382) **Decays D → Kev, D → K*ev, D → πev in QCD sum rules method.** Aliev, T.M. (International Centre for Theoretical Physics, Trieste (Italy)); Ovchinnikov, A.A.; Slobodenyuk, V.A. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 14p. Order Number DE90627497. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The form factors of the semileptonic decays D → Kev, D → K*ev, D → πev are calculated by means of the QCD sum rules method for the three-point correlators. The decay widths are obtained. Our results agree with the experimental data within the theoretical and the experimental uncertainties involved. The restriction on the Kobayashi-Maskava matrix elements V_{cs}, V_{cd} are found. (author). 22 refs, 1 fig.

33438 (IC–89/384) **Radiative decay of the bottom quark and the WWγ coupling.** Chia Swee Ping. International Centre for Theoretical Physics, Trieste (Italy). Nov 1989. 20p. Order Number DE90627510. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The flavour-changing radiative decay b → sγ is analysed, and is found to be sensitive to the WWγ coupling. QCD corrections are found to play an important role. A good measurement of the branching ratio for B → K deg. γ may allow us to test the gauge coupling for WWγ of the Standard Model. (author). 45 refs, 8 figs, 1 tab.

33439 (IC–89/415) **Comment on phenomenology of the almost standard model.** Senda, I. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 11p. Order Number DE90627523. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The phenomenological implications of the almost standard model, which is the modified version of the standard model by adding the vector singlet fermions, are investigated. The contribution of the exotic fermions to the radiative corrections are estimated in the processes such as the K_0-K-bar$_0$ mixing and $K_L \rightarrow \mu\mu$-bar decay. It is suggested that they might give comparable effect to these processes as that of the standard fermions. (author). 8 refs, 3 figs.

33440 (IFT-P–17/89) **Mass differences of light hadron isomultiplets.** Palladino, B.E.; Ferreira, P.L. Instituto de Fisica Teorica (IFT), Sao Paulo, SP (Brazil). 1989. 34p. Order Number DE90627511. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Mass differences of low-lying, non-strange, hadron isomultiplets are investigated in the framework of a relativistic, independent quark potential model, implemented by center-of-mass, one-gluon-exchange and pion-cloud corrections. The introduction of pionic self-energy corrections with non-degenerate intermediate states is instrumental in our analysis, playing also a fundamental role for a successful description of the ρ-ω mass splitting. The effect of the supersposition of all these corrections is discussed in some detail for the p-n, Π^+-Π^0, ρ^+-ρ^0 and Δ^{++}-Δ^0 mass differences. The corresponding hadronic masses are also calculated with suitable values for the hardronic sizes and quark masses. (author).

33441 (IFT-P–19/89) **Observed supersymmetry in baryon and meson spectra with IBFM, the interacting boson fermion model.** Dey, J. (Maulana Azad Coll., Calcutta (India). Dept. of Physics); Dey, M. Instituto de Fisica Teorica (IFT), Sao Paulo, SP (Brazil). 1989. 10p. Order Number DE90627524. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Supersymetry is already observed in (i) nuclear physics where the same empirical formula based on a graded Lie group describles even-even and odd-even nuclear spectra and (ii) in Nambu-BCS theory where there is a simple relationship between the energy gap of the basic fermion and the bosonic collective modes. Similar relationships between large number of mesonic and baryonic excitations based on the SU(3) substructure in the U(15/30) graded Lie group, are proposed. (author).

33442 (IFT-P–26/89) **Prediction for mesonic spectrum from the discrete quark-gluon states of a finite size bag.** Dey, J. (Maulana Azad Coll., Calcutta (India)); Tomio, L.; Dey, M. Instituto de Fisica Teorica (IFT), Sao Paulo, SP (Brazil). 1989. 8p. Order Number DE90627512. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The mesonic spectrum from the kaon mass to 1300 MeV $_{15}$ fitted very well by a density of states ρ(m) calculated without free parameters. In the 200 to 400 MeV range there is no experimental state and calculated ρ(m)dm also shows a minimum at this energy. The partition function has very significant finite size effects leading to a substantial lowering of the density of states for small masses. (author).

33443 (IPNO-TH–88-55) **Consistent three-nucleon forces in the nuclear many-body problem.** Mathiot, J.F. (Paris-11 Univ., 91 - Orsay (FR). Inst. de Physique Nucleaire); Lejeune, A.; Martzolff, M.; Grange, P. Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire. 1988. 62p. Contract NATO-025.81. Order Number DE90792883. Available from NTIS (US Sales Only), PC A04/MF A01.

Describing an assembly of an infinite number of nucleons in interaction via a two-body potential as a non-relativistic many body problem in the first place, we envisage corrections to this picture due to suppressed degrees of freedom at the level of the two-body potential. At variance with relativistic many-body theory, the solution of the non-relativistic problem with a two-body potential only is sufficiently under control at present so that evaluating corrections in this framework is of particular interest. These corrections come primarily from additional three-body forces either due to finite density effects (Pauli blocking of fermions) or are of genuine origin: relativistic dynamical processes and effects from the intrinsic structure of the nucleon. Recalling the successful treatment of electromagnetic interactions in nuclei in terms of meson-exchange currents, we establish novel consistency requirements between the initial two-body force and the well identified residual three-body force. The nucleon-antinucleon pair term required in the analysis of meson-exchange currents has a genuine three-body counterpart resulting from time ordered diagrams containing a single Z-branch. Its contribution to the energy per particle is repulsive and varies

with a high power of the density. Thereby we obtain the important saturating effect present in relativistic mean field approaches. We envisage next the role of the first radial nucleon resonance N^* (1/2, 1/2) (Roper resonance) in inducing a specific three-body force. The meson-nucleon-Roper coupling constants and form factors are evaluated in a relativistic quark model. Gathering all self-consistent corrections to the binding energy per particle of infinitely many nucleons, we find that the final equation of state is solely governed by the density dependence of medium corrections to the free σ-meson mass. We discuss a first attempt to extract this density dependence.

33444 (KFK–4706) **Neutron-proton scattering.** Doll, P. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Kernphysik. Feb 1990. 198p. (CONF-900147–: 13. symposium on nuclear physics, Oaxtepec (Mexico), 3-6 Jan 1990). Order Number DE90792534. Available from NTIS (US Sales Only), PC A09/MF A01.

Neutron-proton scattering as fundamental interaction process below and above hundred MeV is discussed. Quark model inspired interactions and phenomenological potential models are described. The seminar also indicates the experimental improvements for achieving new precise scattering data. Concluding remarks indicate the relevance of nucleon-nucleon scattering results to finite nuclei. (orig.).

33445 (KFKI–1989-47/A) **Entropy content from strange particle ratios in the E802 experiment.** Levai, P.; Lukacs, B.; Zimanyi, J. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Sep 1989. 33p. Order Number DE90627526. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A method is given to reconstruct the local state of a heavy ion collision which produced the detected particles. Only some particle ratios are needed; in the simplest case 2 of them determines the local state if it was in complete thermodynamic equilibrium, and the assumption is checked later. Applying the method on the available data of the E802 experiment, $T \approx 120$ MeV, $n/n_0 \approx 0.4$ and $S/N_B \approx 14$ is obtained, which is a reasonable break-up stage. (author) 22 refs.; 7 figs.

33446 (KFKI–1989-48/A) **Entropy production in the relativistic heavy ion collisions.** Holme, A.K. (Bergen Univ. (Norway). Dept. of Physics); Csernai, L.P.; Levai, P.; Papp, G. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Sep 1989. 24p. Order Number DE90627527. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A short overview is given on the most important possibilities of entropy production in the relativistic heavy ion collisions, which is connected to the shock phenomena. The E802 experiment is considered as an example, where one can determine the specific entropy content from measured strange particle ratios. The received large entropy value ($S/N_B \approx 14$) can be explained by assuming quark-gluon plasma formation. The possibility of overcooling of quark-gluon plasma and its deflagration are also investigated. (author) 22 refs.; 4 figs.

33447 (KURRI-TR–318, pp. 43-49) **Study on (γ, π^+), (γ,π^-xn) rections, photo-spallation and photo-fragmentation reaction.** Fujiwara, I. (Otemon Gakuin Univ., Ibaraki, Osaka (Japan)); Sakamoto, K.; Hamagima, Y. Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. May 1989. (In Japanese). (CONF-8901177–: 1. specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor, Kumatori (Japan), 24-25 Jan 1989). In *Proceedings of the 1st specialist research meeting on studies of nuclear chemistry and nuclear physics at research reactor.* Order Number DE90741373. Available from NTIS (US Sales Only), PC A06/MF A01.

Interaction between nuclei and high-energy photons results in the generation of delta's. The study uses a radiochemical technique to examine excitation functions for the generation cross section of nuclides which are produced as a result of the release of pai's out of the nucleus following the generation of delta's. The (γ, π^+) reaction can be distinguished radiochemically because there are no other reactions in which the nucleus undergoes a change in its atomic number, but not in its mass. It is also possible to distinguish the (γ, π^-xn) reaction radiochemically because there are no other reactions in which the atomic number of the nucleus increases. A wide variety of data on these reactions are collected and analyzed. The yield of spallation products obtained under the same irradiation conditions is analyzed by using the Rudstam equation. The parameters obtained from this analysis are studied systematically. The investigations suggest that most of the pai's resulting from the decay of delta's are absorbed by the nucleus to generate a large energy leading to spallation reaction. (N.K.).

33448 (LAPP-TH–248-89) **Phenomenological study of the polarized lepto production.** Chiappetta, P.; Girardi, G. Grenoble-1 Univ., 74 - Annecy (France). Lab. de Physique des Particules Elementaires. Apr 1989. 10p. Order Number DE90792999. Available from NTIS (US Sales Only), PC A02/MF A01.

In this note we make a phenomenological study of the recent EMC data on polarized structure function $g_1^p(x)$. Using general principles like Regge behaviour and positivity we derive simple parametrizations for quark and gluon polarized distribution function and obtain a consistent description of experimental data.

33449 (LPNHEP–88-05) **A unified description of the perturbative photon structure function in x space.** Kapusta, F. Paris-6 Univ., 75 (France). Lab. de Physique Nucleaire et de Hautes Energies; Paris-7 Univ., 75 (France). Apr 1988. 12p. Order Number DE90792989. Available from NTIS (US Sales Only), PC A03/MF A01.

We give here in detail the derivation of the various contributions to the photon structure function in the perturbative region. The low x region problem is pointed out and the QCD corrections to the hadronic part are discussed, including the quasi perturbative region of higher twist effects. The transition from high Q^2 to low Q^2 is examined and the basis for a realistic and consistent simulation of higher order QCD processes is given.

33450 (NBI-HE–90-01) **The good, the bad, and the baryon.** Ball, R.D. Niels Bohr Inst., Copenhagen (Denmark). Jan 1990. 47p. (CONF-8910403–: 11. autumn school in physics on hadrons: their structure and interactions, Lisbon (Portugal), 9-14 Oct 1989). Order Number DE90625644. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We describe the incorporation of baryons into an effective theory of QCD at low energies. The baryon is not a Skyrmion, rather it consists of three valence quarks bound by effective gluon exchanges, enveloped in a meson cloud, which may possibly take the form of a chiral soliton. Some of the physical implications of these results are also discussed. (orig.).

33451 (UCRL-JC–103865) **The nucleon-nucleon interaction in the presence of the electromagnetic field: Nucleon-nucleon bremsstrahlung.** Brown, V.R. Lawrence Livermore National Lab., CA (USA). Apr 1990. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900179–3: Los Alamos National Laboratory (LANL) workshop on n-p Bremsstrahlung, Los Alamos, NM (USA), 25-26 Jan 1990). Order Number DE90010871. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The present workshop was organized primarily to investigate the interest in, the value of, and the feasibility of doing an npγ experiment using the neutron "white source" at LANL. An increasing amount of US nuclear physics dollars are being spent on electronuclear physics. npγ is a fundamental process with large meson-exchange currents. In the npγ calculations of Brown and Franklin, the meson-exchange contributions increase the cross section by a factor of roughly two and alter the angular distribution of the emitted photon dramatically. The details of these calculated effects have never been verified experimentally, but the proper quantum-mechanical inclusion of meson-exchange contributions, using the methods of Brown and Franklin, has proved to be essential in understanding the heavy-ion results. The understanding of the importance of such terms is extremely important in electronuclear processes, such as are presently under investigation or being planned at Bates, SLAC, and CEBAF. Just one example is in the electrodisintegration of the deuteron, where meson-exchange contributions must be included properly before any conclusions about

nuclear models, such as QCD versus meson-exchange potentials can be made. $np\gamma$ studies in conjunction with similar electronuclear studies, where the photon is virtual, suggest a mutually beneficial partnership.

33452 Recognizing the next heavy quark at $p\bar{p}$ colliders. Barger, V. (Physics Department, University of Wisconsin, Madison, Wisconsin 53706 (US)); Phillips, R.J.N. *Physical Review, D (Particles Fields) (USA),* 41(1): 52-58 (1 Jan 1990). DOE Contract AC02-76ER00881.

The next heavy quark is likely to be found first at $p\,\bar{p}$ colliders rather than at e^+e^- machines, in which case the expected signals from different kinds of candidate quark will be rather similar. We discuss the problem of distinguishing between the awaited top quark *t*, a possible fourth-generation charge $-(1/3)$ quark *v*, and an exotic isosinglet charge $-(1/3)$ quark *h*.

33453 *W*-boson-plus-two-jet production at the Fermilab Tevatron. Mangano, M. (Istituto Nazionale di Fisica Nucleare, S. Piero a Grado, Pisa, Italy (IT)); Parke, S. *Physical Review, D (Particles Fields) (USA),* 41(1): 59-64 (1 Jan 1990).

In this paper we present a detailed study of rates and distributions for the production of a *W* boson plus two jets at the Fermilab 1.8-TeV Collider, assuming that the top quark does not contribute to these events. This process is the principal background to the discovery of a top quark in the 80–110-GeV range with 5 pb^{-1} of data at the Fermilab Tevatron.

33454 Hadron-collider limits on new electroweak interactions from the heterotic string. del Aguila, F. (Departamento de Fisica Teorica, Universitat Autonoma de Barcelona, Bellaterra E-08193 Barcelona, Spain (ES)); Moreno, J.M.; Quiros, M. *Physical Review, D (Particles Fields) (USA),* 41(1): 134-141 (1 Jan 1990). AE-88-0040-01.

We evaluate the $Z'\to l^+l^-$ cross section at present and future hadron colliders, for the minimal (E_6) extended electroweak models inspired by superstrings (including renormalization effects on new gauge couplings and new mixing angles). Popular models are discussed for comparison. Analytical expressions for the bounds on the mass of a new gauge boson, $M_{Z'}$, as a function of the bound on the ratio $R\equiv\sigma(Z')B(Z'\to l^+l^-)/\sigma(Z)B\ (Z\to l^+l^-)$, are given for the CERN Sp $\bar{p}$S, Fermilab Teva- tron, Serpukhov UNK, CERN Large Hadron Collider, and Superconducting Super Collider for the different models. In particular, the $M_{Z'}$ bounds from the present *R* limit at CERN, as well as from the eventually available *R* limits at Fermilab and at the future hadron colliders (after three months of running at the expected luminosity), are given explicitly.

33455 Influence of the B^* resonance on $\bar{B}\to\pi e\bar{\nu}_e$. Isgur, N. (Department of Physics, University of Toronto, Toronto, Canada M5S 1A7 (CA)); Wise, M.B. *Physical Review, D (Particles Fields) (USA),* 41(1): 151-154 (1 Jan 1990). DOE Contract AC03-81ER40050.

In the chiral limit and as $m_b\to\infty$, the decay $\bar{B}\to\pi^+e\bar{\nu}_e$ would be dominated near zero pionic recoil by the effects of the B^* resonance. We examine the influence of this mechanism on the $\bar{B}\to Xe\bar{\nu}_e$ electron spectrum in the region near the end point which is important for the determination of the Kobayashi-Maskawa matrix element V_{ub}.

33456 Interpretation of the neutron electric dipole moment: Possible relationship to $|\epsilon'|$. Booth, M.J. (Enrico Fermi Institute and Physics Department, The University of Chicago, 5640 South Ellis Avenue, Chicago, Illinois 60637 (US)); Briere, R.A.; Sachs, R.G. *Physical Review, D (Particles Fields) (USA),* 41(1): 177-181 (1 Jan 1990). DOE Contract AC02-80ER10587.

Recent measurements of D_n indicate that it *may* be of order G_F (milliweak), which is much larger than predicted by the Kobayashi-Maskawa (KM) model. The predicted KM moment is shown to be small because it is of second order in G_F (superweak) *and* suppressed by the Glashow-Iliopoulos-Maiani (GIM) mechanism. GIM cancellations have their largest effect on the calculation of the moment of a single quark so that *W*-exchange contributions between pairs of quarks dominate D_n in the KM model. Experimental confirmation that D_n is of order G_F (in the range 10^{-27}–10^{-25} e cm) would require a *T*-violating phase between the *P*-conserving and *P*-violating first-order weak interactions, as occurs in the Weinberg model. Any such *T* violation would lead to a relationship between ϵ' and D_n of the form $|D_n|\sim|\epsilon'|$. We estimate the ratio $|D_n/\epsilon'|$ for the Weinberg model, and show that it is consistent with current data on D_n, $|\epsilon'/\epsilon|$, and $|\epsilon|$. However, the current data are also consistent with $D_n=\epsilon'=0$, so that a firm conclusion cannot be drawn now.

33457 Higher-order corrections to the scalar quark density in the proton. Bernard, V. (Centre de Recherches Nucleaires et Universite Louis Pasteur de Strasbourg, Groupe de Physique Nucleaire Theorique, BP 20 Cr, F-67037 Strasbourg CEDEX, France (FR)); Meissner, U. *Physical Review, D (Particles Fields) (USA),* 41(1): 203-207 (1 Jan 1990). DOE Contract AC02-76ER03069.

We investigate the self-energy of constituent quarks to second order in the two-flavor Nambu–Jona-Lasinio model. We show that the effect of flavor quenching with increasing quark mass as found previously by use of the Hartree-Fock approximation persists. We furthermore discuss the nonanalyticity of the nucleon mass in the quark masses. This is in accordance with rigorous results from chiral perturbation theory.

33458 Quark masses and mixing angles from universal seesaw mechanism. Davidson, A. (Department of Physics, Ben-Gurion University of the Negev, Beer Sheva 84105, Israel (IL)); Ranfone, S.; Wali, K.C. *Physical Review, D (Particles Fields) (USA),* 41(1): 208-218 (1 Jan 1990). DOE Contract FG02-85ER40231.

A universal seesaw mechanism is invoked to account for the observed fermion mass hierarchies. In the framework of left-right symmetry, heavy fermions (mass scale χ) which are $SU(2)_L\otimes SU(2)_R$ singlets are postulated while retaining the simplest possible Higgs system: namely, $\phi(1,2,1)_{+1}\oplus\phi(1,1,2)_{+1}$ accompanied by a left-right singlet $\sigma(1,1,1)_0$ in the standard $SU(3)_C\otimes SU(2)_L\otimes SU(2)_R\times U(1)_{B-L}$ notation. Every conventional quark and lepton is accompanied by a nonmirror singlet heavy fermion, so that the associated mass matrix is doubled and has the seesaw form usually associated only with the neutrino mass matrix. In the single-generation case, the model provides a plausible explanation for the mass hierarchy $m_{e,u,d}\sim10^{-4}M_W$ and predicts $m_{\nu_e}m_{\nu_h}\approx m_e^2$, thus accounting for the superlightness of neutrinos. Combined with a U(1) axial symmetry, the mechanism provides a formalism in which the generations are distinguished and constraints emerge on the allowed form of mass matrices. In this paper, we consider the realistic case of three generations in a simplified version of the model in which *CP* violation does not arise from the gauge sector. Choosing the $U(1)_A$ quantum numbers so that the mass matrices are of the Fritzsch type, we calculate experimentally measured Cabibbo-Kobayashi-Maskawa matrix elements V_{us}, V_{ub}, and V_{cs} and derive their dependence on quark mass parameters.

33459 Radiative neutrino decay in a medium. D'Olivo, J.C. (Instituto de Ciencias Nucleares— Universidad Nacional Autonoma de Mexico— Circuito Exterior, Ciudad Universitaria, 04510 Mexico, Distrito Federal, Mexico (MX)); Nieves, J.F.; Pal, P.B. *Physical Review Letters (USA),* 64(10): 1088-1090 (5 Mar 1990).

We calculate the rate of decay of a heavy neutrino into a lighter neutrino and a photon in a background that contain electrons but no μ's or τ's. Unlike the same decay in the vacuum, the rate of this process is not suppressed by the Glashow-Iliopoulos-Maiani mechanism. Some physical implications of the process are discussed.

33460 Topological soliton model calculation of the proton-proton parity-violating interaction. Driscoll, D.E. (Institute for Nuclear Theory, Department of Physics, University of Washington, Seattle, Washington 98195 (USA)); Meissner, U. *Physical Review, C (Nuclear Physics) (USA),* 41(3): 1303-1305 (Mar 1990). DOE Contract AC02-76ER03069.

We present a calculation of the parity-violating analyzing power in proton-proton scattering using weak coupling constants predicted by the topological chiral soliton model of the nucleon. The results are compared with the predictions using quark-model parity-violating parameters. We also perform a calculation using weak and strong vertex functions obtained consistently from the chiral soliton model. Within the framework of that model, we can justify

the use of the same form factors for the weak and strong meson-nucleon vertices. We discuss the predictive power of a planned experiment at T_{lab}=222 MeV.

33461 Fractal measures in multiparticle production. Hwa, R.C. (Institute of Theoretical Science— Department of Physics, University of Oregon, Eugene, Oregon 97403 (USA)). *Physical Review, D (Particles Fields) (USA),* 41(5): 1456-1462 (1 Mar 1990). DOE Contract FG06-85ER40224.

A new set of moments G_q of the multiplicity distribution in a narrow rapidity window is suggested for analysis so that the chaotic fluctuations of the rapidity distribution can be described in the formalism of multifractals. Phenomenological evidence is given to show that there is a fractal structure in the data of multiparticle production at high energy. The fractal dimension and its generalizations can be determined to provide a description of the spectrum of scaling indices. The implication on the emergence of a new approach to the study of multiparticle production in the framework of multifractals in the theory of chaos is discussed.

33462 Nonresonant three-body decays of charmed mesons. Chau, L. (Department of Physics, University of California, Davis, California 95616 (USA)— Center for Nonlinear Science, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (USA)); Cheng, H. *Physical Review, D (Particles Fields) (USA),* 41(5): 1510-1516 (1 Mar 1990).

Nonresonant three-body decays of charmed mesons are first studied in the approach of effective SU(4)×SU(4) chiral Lagrangians. It is pointed out that the predictions of the branching ratios in chiral perturbation theory are in general too small when compared with experiment. However, the experimental results are comprehensible in the general framework of the quark-diagram scheme. The existence of a sizable *W*-annihilation amplitude, which is evident by the observation of $D_s^+ \to (\pi^+\pi^+\pi^-)_{NR}$, is the key toward an understanding of the three-body nonresonant decays of D^+ and D_s^+. The measurement of $D^0 \to \bar{K}^0 K^+ K^-$ and $D^0 \to \bar{K}^0\pi^+\pi^-$ indicates that color suppression is not effective in the three-body decay. Based on the quark-diagram analysis, predictions for some other nonresonant modes are given.

33463 *Z*-boson decays to heavy quarkonium. Barger, V. (Physics Department, University of Wisconsin, Madison, Wisconsin 53706 (USA)); Cheung, K.; Keung, W. *Physical Review, D (Particles Fields) (USA),* 41(5): 1541-1546 (1 Mar 1990). DOE Contract AC02-76ER00881;FG02-84ER40173.

We evaluate the decays $Z \to Q\bar{Q}$ of Z bosons to $^3S_1(Q\bar{Q})$ and $^1S_0(Q\bar{Q})$ quarkonium states of charm and bottom quarks. We find partial widths of $\Gamma(Z \to c\bar{c}\psi/J)$=47 keV, $\Gamma(Z \to c\bar{c}\eta_c)$=145 keV, $\Gamma(Z \to b\bar{b}\Upsilon_b)$=6.4 keV, and $\Gamma(Z \to b\bar{b}\eta_b)$=6.5 keV, that might be observable at the CERN e^+e^- collider LEP. We also calculate the partial widths for $W^+ \to c\bar{s}\psi/J$, $t \to W^+ b\Upsilon_b$, $\eta_Q \to Zgg$, and $Z \to \eta_{c,b}gg$ decays.

33464 Neutral-Higgs-boson contribution to the electric dipole moment of the neutron. Valencia, G. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973 (USA)). *Physical Review, D (Particles Fields) (USA),* 41(5): 1562-1567 (1 Mar 1990). DOE Contract AC02-76CH00016.

We examine the neutron electric dipole moment in models where *CP* violation occurs in the (enlarged) Higgs sector. In particular, we study the contributions of neutral-scalar exchange between two light quarks and find that there is a substantial enhancement relative to the usual estimates (which consider quark electric dipole moments) where such contributions are neglected. At present, we cannot calculate reliably the resulting value for the neutron electric dipole moment, but we find it to be of order 10^{-28} e cm for Higgs-boson masses of order 100 GeV.

33465 Vector-meson contributions to the processes $\gamma\gamma \to \pi^0\pi^0, \pi^+\pi^-$, $K_L \to \pi^0\gamma\gamma$, and $K^+ \to \pi^+\gamma\gamma$. Ko, P. (Enrico Fermi Institute— Department of Physics, University of Chicago, Chicago, Illinois 60637 (USA)). *Physical Review, D (Particles Fields) (USA),* 41(5): 1531-1540 (1 Mar 1990). DOE Contract AC02-80ER10587.

We implement standard chiral perturbation theory to $O(p^4)$ by adding vector mesons. We show that it leads to a good agreement of the prediction for $\sigma(\gamma\gamma \to \pi^0\pi^0)$ with experiments and the vector mesons unitarize the chiral amplitude in an effective way. We also consider $K_L \to \pi^0\gamma\gamma$, including the effect of vector mesons, and obtain a very distinct spectrum for two photons. Also, their effects on $\gamma\gamma \to \pi^+\pi^-$ and $K^+ \to \pi^+\gamma\gamma$ are briefly discussed.

33466 Anomaly-free left-right-symmetric models with gauged baryon and lepton numbers. He, X. (Research Centre for High Energy Physics, School of Physics, University of Melbourne, Parkville, Victoria 3052, Australia (AU)); Rajpoot, S. *Physical Review, D (Particles Fields) (USA),* 41(5): 1636-1639 (1 Mar 1990). DOE Contract AM03-76SF00010.

A left-right-symmetric extension of the standard electroweak interaction model is presented in which baryon- (*B*-) and lepton- (*scrL*-) number conservation are considered as spontaneously broken gauge symmetries. The gauge, global, and the mixed gauge-gravitational anomalies in the model are canceled by invoking new fermion matter that carries baryon as well as lepton numbers. We find a class of models in which the exotic fermions carry the same electric charges as the *N* families of conventional fermions but different *B* and *scrL* charges. The Higgs structure in this case allows a light massive neutral boson with a lower bound of 120 GeV.

33467 On the detection of the radiation amplitude zero in $e^\pm p$ collisions. Reid, J. (Department of Physics, University of Tulsa, Tulsa, Oklahoma 74104 (USA)); Li, G.; Samuel, M.A. *Physical Review, D (Particles Fields) (USA),* 41(5): 1675-1678 (1 Mar 1990). DOE Contract FG05-85ER40215.

The processes $e^\pm p \to e^\pm p\gamma$ are reconsidered. It is shown that the radiation amplitude zero in $e^+p \to e^+p\gamma$ is clearly visible, allowing a direct measurement of the u-quark charge, via real photons. In the case of $e^-p \to e^-p\gamma$, however, the zero is washed out. These conclusions agree with those of a recent paper by Couture.

33468 Flavor-mixing structure functions in the Nambu–Jona-Lasinio model. Korpa, C.L. (Istituto Nazionale di Fisica Nucleare Sezione di Roma, I-00185 Roma, Italy (IT) — Physics Department, Oregon State University, Corvallis, Oregon 97331 (USA)); Meissner, U. *Physical Review, D (Particles Fields) (USA),* 41(5): 1679-1682 (1 Mar 1990). DOE Contract AC02-76ER03069.

The distribution of the strange quarks in the constituent light (up or down) quark, as seen in deep-inelastic scattering, is calculated for first nonvanishing order in the generalized Nambu–Jona-Lasinio model. Using a previous fit to determine the parameters of the model, the result is compared to experimental bounds on the momentum carried by strange quarks and antiquarks in the nucleon. No violation of experimental bounds is obtained.

33469 Completely ununified standard model. Rajpoot, S. (Department of Physics, University of California, Riverside, California 92521 (USA)). *Physical Review, D (Particles Fields) (USA),* 41(5): 1706-1708 (1 Mar 1990). DOE Contract AM03-76SF00010.

A model of electroweak interactions is presented in which quarks transform under the quark-matter electroweak symmetry G^q=SU(2)$_L{}^q$×U(1)$_Y{}^q$ and leptons transform under the leptonic-matter electroweak symmetry G^l=SU(2)$_L{}^l$×U(1)$_Y{}^l$. The standard electroweak interactions are the diagonal sum of $G^q \times G^l$ interactions resulting from spontaneous symmetry breaking. In this model the charged and neutral bosons behaving like the *W* and *Z* of the standard model have mass lower bounds of order 1 TeV while there exists the possibility of an additional massive neutral boson with mass as low as 150 GeV.

33470 Gluon fusion as a source for massive-quark polarization. Dharmaratna, W.G.D. (Department of Physics, Tufts University, Medford, Massachusetts 02155 (USA)); Goldstein, G.R. *Physical Review, D (Particles Fields) (USA),* 41(5): 1731-1735 (1 Mar 1990).

It is well known that single-polarization asymmetries are large in hyperon production in contrast with naive QCD predictions. We have explored the possibility of polarization of quarks through "gluon fusion," assuming that the quark mass can be significant at energies of interest. The fourth-order contribution to the single-spin asymmetry in $g+g \to s+\bar{s}$ is calculated. Properties of the polarization of the strange quark in the hadron center-of-mass frame are discussed. A fit to the hyperon polarization is presented that reproduces the unique and striking kinematic dependence of the data.

This is evidence that gluon fusion can be taken as a serious candidate for the "seed" of polarization.

33471 Radiative corrections and semileptonic *B* decays. Atwood, D. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973 (USA)); Marciano, W.J. *Physical Review, D (Particles Fields) (USA)*, 41(5): 1736-1740 (1 Mar 1990). DOE Contract AC02-76CH00016.

A prescription for approximating electroweak radiative corrections to weak decays is given. The method is illustrated for $\tau \to e\nu\bar{\nu}$ and a simplified (structureless) model of $B \to Me\bar{\nu}$, $M = D$ or π, where the complete $O(\alpha)$ corrections are known. Our procedure is shown to provide a proper description of radiation damping near the electron's end-point energy and a reasonable estimate of radiative corrections for much of the spectrum as well as the integrated rate. As a practical application, it is applied to the semileptonic decays $B \to Xe\bar{\nu}$ where an exact $O(\alpha)$ treatment of radiative corrections is very difficult, but an estimate of their effect is important for the extraction of V_{ub} and leptonic branching ratios. We also discuss an 18% enhancement of $\Upsilon(4S) \to B^+B^-$ relative to $B^0\bar{B}^0$ due to large Coulomb corrections near threshold.

6453 Particle Invariance Principles and Symmetries

Refer also to citation(s) 33454, 33458, 33462, 33464, 33469, 33503, 33511, 33512, 33515, 33517, 33518, 33519, 33524

33472 (CBPF-NF–033/89) **A higher-order analysis of the effects of breaking supersymmetry for non-linear σ-models.** Helayel-Neto, J.A.; Smith, A.W. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 35p. Order Number DE90627276. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Arbitrary (1,1) and (1,0) two-dimensional non-linear σ-models, modified by the addition of coupling terms which explicitly break supersymmetry, are studied. The geometrical meaning of these additional terms is discussed. Supergraph methods, suitably extended to include the case of broken supersymmetry, are set and employed in explicity higher-loop computations to keep track of the effect that the explicity breaking of supersymmetry has on the ultraviole behaviour of the originally supersymmetric models. (author).

33473 (CBPF-NF–035/89) **Torsion-induced gauge superfield mass generation for gauge-invariant non-linear σ-models.** Helayel-Neto, J.A. (International Centre for Theoretical Physics, Trieste (Italy)); Mokhtari, S.; Smith, A.W. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 15p. Order Number DE90627277. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

It is shown that the explicit breaking of (1,0) supersymmetry by means of a torsion-like term yields dynamical mass generation for the gauge superfields which couple to a (1,0) - supersymmetric non-linear σ-model. (author).

33474 (CBPF-NF–043/89) **Gauge transformations for six dimensional superfields.** Bollini, C.G.; Giambiagi, J.J. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 20p. Order Number DE90627278. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

For D = 6 the general gauge transformations that keep the superfield within the Wess-ZuMino gauge (any component with less than two indices of each type $\alpha,\dot{\alpha}$ is absent) are proposed. The gauge in variant components are built and all partial lagrangians are written down. Finally a dimensional reduction to D = 4, is briefly discussed. (author).

33475 (CBPF-NF–047/89) **The stability of the classical Skyrme model SU(2) hedgehog soliton.** Mignaco, J.A. (Universidade Federal, Rio de Janeiro, RJ (Brazil). Inst. de Fisica); Wulck, S. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 12p. Order Number DE90627279. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

It is presented the exact power series solution at the origin for the classical SU(2) Skyrme model lagrangean with a hedgehog ansatz. The analogous solution at infinity is also considered, and the dependence of the chiral angle on two dimensionless variable is exhibited (a consequence of having two completely arbitrary parameters). The classical Skyrme model soliton turns out to be as unstable as the pure non-linear sigmahe Skyrme parameter is fixed, breaking the scale invariance on both variables, the mass of the soliton has a stable minimum. (author).

33476 (INS–800) **BRS symmetry in stochastic quantization of the gravitational field.** Nakazawa, Naohito. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Dec 1989. 14p. Order Number DE90791127. Available from NTIS (US Sales Only), PC A03/MF A01.

We study stochastic quantization of gravity in terms of a BRS invariant canonical operator formalism. By introducing artificially canonical momentum variables for the original field variables, a canonical formulation of stochastic quantization is proposed in a sense that the Fokker-Planck hamiltonian is the generator of the fictitious time translation. Then we show that there exists a nilpotent BRS symmetry in an enlarged phase space for gravity (in general, for the first-class constrained systems). The stochastic action of gravity includes explicitly an unique De Witt's type superspace metric which leads to a geometrical interpretation of quantum gravity analogous to nonlinear σ-models. (author).

33477 (INS–805) **Zero modes in vortex-fermion system with compact extra space.** Nakamura, A. (Tokyo Metropolitan Univ. (Japan). Dept. of Physics); Shiraishi, K. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Jan 1990. 12p. Order Number DE90791142. Available from NTIS (US Sales Only), PC A03/MF A01.

The existence of fermionic zero modes is shown in the presence of vortex configuration of pure SU(2) gauge field on the manifold $M^4 \times S^2$. From the perspective of four dimensional effective theory, these zero modes are almost the same as Jackiw-Rossi type zero modes of the vortex-fermion system. (author).

33478 (RRK–90-1) **The Weil-Petersson Kaehler form on the super Teichmueller space.** Uehara, Shozo; Yasui, Yukinori. Hiroshima Univ., Takehara (Japan). Research Inst. for Theoretical Physics. Jan 1990. 11p. Order Number DE90791139. Available from NTIS (US Sales Only), PC A03/MF A01.

We introduce super length functions providing local coordinates for the super Teichmueller space. Then we give the Weil-Petersson Kaehler form in terms of the super functions. (author).

33479 Dynamically generated fermionic masses. Cvetic, M. (Stanford Linear Accelerator Center, Stanford Univ., Stanford, CA (US)). 443-452 of Superstrings, unified theories and cosmology. Furlan, G.; Jengo, R.; Pati, J.C.; Sciama, D.W.; Sezgin, E.; Shafi, Q. World Scientific Pub. Co., Teaneck, NJ (USA) (1987). DOE Contract AC03-76SF00515. (CONF-8606312–: Summer workshop on superstrings, unified theories and cosmology, Trieste (Italy), 30 Jun - 15 aug 1986).

The fermion mass hierarchy problem is presented in the context of supersymmetric vector-like theories as well as within effective gauge theories with Yukawa interactions between Higgs-like scalars and chiral fermions. The authors present the results for the latter theories from the point of view of Higgs mechanism as well as from that of dynamical symmetry breaking through formation of two-body condensates.

33480 A flaw in the universal mirror. Adair, R.K. (Brookhaven National Lab., Upton, NY (USA)). *Scientific American (USA)*, 258(2): 50-56 (Feb 1988).

The existence of the universe as we know it comes from a flaw in a symmetry exhibited by a universal mirror called the CP mirror; a symmetry that says the outcomes of some events in nature should remain the same on changing matter to antimatter (C) and viewing the result in a mirror (P). New theoretical ideas developed in the past few years have driven a new generation of experiments that promise to throw new light on the flaw. These experiments are conceived to examine the character of the force responsible for CP symmetry and to determine if the very small asymmetry follows from a weak (milliweak) force acting twice or a very weak (superweak) force acting once in particle interactions. In 1964, James Cronin and Val Fitch showed that small violations of CP symmetry occurred for neutral K mesons. Clearly the set of neutral K mesons

forms a system that provides for particularly sensitive tests of CP invariance violation. Both milliweak and superweak concepts are not so much theories as they are sets of theories. Results from recent experiments at Brookhaven National Laboratory and Fermi Laboratory have served to exclude some but not all interesting milliweak models of CP invariance violation. 6 figs.

33481 **Standard-model predictions for *CP* violation in B^0-meson decay.** Dib, C.O. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94309 (USA)); Dunietz, I.; Gilman, F.J.; Nir, Y. *Physical Review, D (Particles Fields) (USA)*, 41(5): 1522-1530 (1 Mar 1990). DOE Contract AC03-76SF00515.

We examine the present set of constraints on the parameters of the standard model and use the unitarity triangle to present their allowed range. We give the implications of this for *CP* violation in the *B*-meson system as a function of top-quark mass, emphasizing what luminosity of an electron-positron collider is needed to guarantee a statistically significant asymmetry in one or more *B* decay channels.

33482 **Minimal dynamical symmetry breaking of the standard model.** Bardeen, W.A. (Fermi National Accelerator Laboratory, P.O. Box 500, Batavia, Illinois 60510 (USA)); Hill, C.T.; Lindner, M. *Physical Review, D (Particles Fields) (USA)*, 41(5): 1647-1660 (1 Mar 1990).

We formulate the dynamical symmetry breaking of the standard model by a top-quark condensate in analogy with BCS theory. The low-energy effective Lagrangian is the usual standard model with supplemental relationships connecting masses of the top quark, *W* boson, and Higgs boson which now appears as a $\bar{t}\,t$ bound state. Precise predictions for m_t and m_H are obtained by abstracting the compositeness condition for the Higgs boson to boundary conditions on the renormalization-group equations for the full standard model at high energy.

33483 **Searching for *CP* violation in "charge-blind" jets.** Kamionkowski, M. (Enrico Fermi Institute, The University of Chicago, Chicago, IL (USA)— Department of Physics, The University of Chicago, Chicago, Illinois 60637 (USA)). *Physical Review, D (Particles Fields) (USA)*, 41(5): 1672-1674 (1 Mar 1990). DOE Contract AC02-80ER10587.

Although it is difficult to determine the identity of the parent parton of hadronic jets produced in high-energy particle-antiparticle collisions, "charge-blind" jets, those where such information is not determined, may still be used to obtain *CP*-violating correlations. In this paper, I provide a general method for determining which correlations may be used as signatures of *CP* violation.

6454 Field Theory

Refer also to citation(s) 33285, 33290, 33455, 33458, 33470, 33479, 33482, 33700, 33713

33484 (GSI–90-12(prepr.)) **Relativistically covariant projection formalism for an interacting quantum field theory.** Buck, P. (Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.)). Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Feb 1990. 44p. Order Number DE90792304. Available from NTIS (US Sales Only), PC A03/MF A01.

A new approach to combine quantum field theory with concepts of non-equilibrium physics is presented. The first step is the derivation of a manifestly covariant equation of motion for the statistical operator, which in a special frame reduces to the von Neumann euqation. On that basis an explicitly covariant projection formalism is developed and then applied to an interacting field theory for fermions and scalar bosons. (orig.).

33485 (IC–89/190) **On Dirac's conjecture for Hamiltonian systems with first and second class constraints.** Cabo, A. (Academia de Ciencias de Cuba, La Habana (Cuba). Inst. de Cibernetica, Matematica y Fisica); Louis Martinez, D. International Centre for Theoretical Physics, Trieste (Italy). Jul 1989. 22p. Order Number DE90627206. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

It is shown for a wide class of systems in the framework of the Total Hamiltonian Procedure that all the first class constraints generate canonical transformations connecting physically equivalent states. It occurs whenever the constraints arising in the Dirac algorithm are effective when considered in the functional form as they appear in the consistency conditions. The property of hereditary separation between first and second class constraints also follows from the above condition. General Poisson bracket relations among constraints in the representation used here are also obtained. The sources of anomalies in the hereditary property reported in the literature are identified. (author). 15 refs.

33486 (IC–89/319) **Construction of mixed fermionic-bosonic string models in four dimensions.** Manida, S.N. International Centre for Theoretical Physics, Trieste (Italy). Oct 1989. 8p. Order Number DE90627207. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The construction of closed string models in four dimensions is discussed. The approach is based on a fermionic formulation for some part of internal (i.e. compactified) coordinates and manifest bosonic compactification into tori for other parts of internal coordinates. The general twisted and shifted boundary conditions are assumed. (author). 24 refs.

33487 (IC–89/321) **Higher loop contributions to effective potential of gauge theory at high temperature.** Belyaev, V.M. International Centre for Theoretical Physics, Trieste (Italy). Oct 1989. 11p. Order Number DE90627208. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Higher perturbative contributions to an effective potential for temporal component of gauge field ($A_0{}^c$=const) for non-abelian gauge theory at high temperature are discussed. It is shown that one of the most important contributions is due to Debye gluons. The condensate of the field A_0 varies as to $gT(g \to 0)$ does not appear, if we take into account this Debye, one- and two-loop contributions only. The behaviour of infra-red leading perturbative contributions is investigated. It is argued that asymptotic behaviour of these terms still indicates to a possible formation of A_0 varies as to gT condensate. Higher perturbative contributions for Debye mass are also discussed. (author). 8 refs, 1 fig.

33488 (IC–89/372) **Membranes, strings, extended elementary particles as singularities of fields.** Barut, A.O. International Centre for Theoretical Physics, Trieste (Italy). Nov 1989. 14p. Order Number DE90627209. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Electromagnetic fields and currents singular on p-dimensional surfaces (p-branes) in Minkowski space are studied as models of p-brane matter (author). 16 refs, 1 tab.

33489 (IC–89/374) **The first order phase transition for six-state Potts model on 2-dimensional random triangle lattice.** Chen Tianlun (International Centre for Theoretical Physics, Trieste (Italy)); Huang Wuqun; Xin Yunwei. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 13p. Order Number DE90627210. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

An optimal Monte Carlo renormalization group method is applied to the 6-state Potts model on a 2-dimensional random triangle lattice. Obviously, the phase transition is of the first order at this phase transition point. The obtained scaling exponent $\nu = 0.54$ and the energy gap $\Delta E = 0.101$ approaches the theoretical and analytical values. (author). 10 refs, 3 figs.

33490 (IC–89/399) **Superconformal algebra and central extension of meromorphic vector fields with multipoles on super-Riemann sphere.** Wang Shikun (Academia Sinica, Beijing, BJ (China). Inst. of Applied Mathematics); Xu Kaiwen. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 7p. Order Number DE90627211. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The superconformal algebras of meromorphic vector fields with multipoles, the central extension and the relevant abelian differential of the third kind on super Riemann sphere were constructed. The background of our theory is concerned with the interaction of closed superstrings. (author). 9 refs.

33491 (IC–89/423) **Trajectories of renormalization group flows on the phase diagram of N=2 superconformal field theories.** Ito, K. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 10p. Order Number DE90627212. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Trajectories of renormalization group flows of N=2 super Landau-Ginzburg field theories are mapped out on the phase diagram N=2 superconformal field theories (SCFTs). It is shown that coupling constants flow on one and the same bifurcation set due to the non-renormalization theorem and the scaling properties of the bifurcation sets. (author). 17 refs, 2 figs.

33492 (IC–89/424) **Topology of singularities and phase diagram of N=2 superconformal field theories.** Ito, K. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 6p. Order Number DE90627213. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Relation between chiral primary fields of an N=2 superconformal model and Milnor monodromy of the corresponding target space singularity is investigated. It is shown that conformal weights of chiral primary fields are identical to one half the difference between spectral numbers and the smallest spectral number. Phase diagram of N=2 superconformal field theories are mapped out. It is shown that they coincide with bifurcation sets in catastrophe theory. The results are applied to the determination of renormalization group flows triggered by two or more relevant operators. (author). 13 refs, 2 figs.

33493 (IC–89/429) **On the unitarity of string propagation on SU(1,1).** Mohammedi, N. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 15p. Order Number DE90627214. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We discuss the consistency (unitarity) of string propagation on the non-compact group SU(1,1) x G_c and find the restrictions on the level of the Kac-Moody algebra for this propagation to be unitary. We also suggest some modifications to the Virasoro generators and obtain a manifestly unitary string theory. (author). 10 refs.

33494 (IC–89/431) **Quantum gravity in two dimensions and the SL(2,R) current algebra.** Helayel Neto, J.A. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro (CBPF), RJ (Brazil)); Smith, A.W.; Mokhtari, S. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 12p. Order Number DE90627215. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Gravity coupled to a scalar field in two dimensions is studied and it is shown that in the light-cone gauge there exists a new symmetry associated with the scalar field that leads naturally to SL(2,R)-Kac-Moody current algebra. This algebra is derived from the traceless part of the energy-momentum tensor whose conservation is shown to give the well-known constraint necessary to obtain the chiral SL(2,R) algebra. (author). 8 refs.

33495 (IC–90/5) **On the relation between the absolute parallelism spaces and spaces having a GL(4) connection.** Melek, M. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 7p. Order Number DE90627222. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

It is shown that the difference between an absolute parallelism connection and a GL(4) connection can be expressed as a tensor field $\omega^{\nu}{}_{\rho\mu}$ under general coordinate transformations which has the property that the quantity $e^{a}{}_{\nu}\, e_{b}{}^{\rho}\, \omega^{\nu}{}_{\rho\mu}$ behaves as a connection under Lorentz transformations. The relations between the equations of geodesics, torsion tensors and curvature tensors are considered. (author). 15 refs.

33496 (IC–90/7) **2+1 topological term, anyons and their possible application in high T_c superconductivity.** Zhu Chuanjie. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 13p. Order Number DE90627223. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

I review pedagogically some aspects about the SO(3) non-linear σ-model and the topological Hopf term (or the abelian Chern-Simons term). I argue that the presence of the topological Chern-Simons term is irrelevant (for regular gauge field configurations). I also give a brief introduction to the ideal anyon gas approach to high T_c superconductivity. (author). 18 refs.

33497 (IC–90/11) **Anyons and Chern-Simons theory on compact spaces of finite genus.** Randjbar-Daemi, S.; Salam, A.; Strathdee, J.A. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 8p. Order Number DE90627216. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

We study the coupling of an Abelian Chern-Simons field to fermions in space-times of the form RxM^2, where M^2 is a compact Riemannian manifold. Upon integrating out the non-zero modes of the Chern-Simons field, an effective N-particle Hamiltonian is constructed, which involves a term representing the effects of the zero modes. We also study the transformation to the fractional statistics (anyon) basis. It is shown that unlike the case of the flat Euclidean M^2 the anyon wave equation involves some residual metric dependent interactions, and the wave function is multivalued. (author). 7 refs.

33498 (IC–90/20) **Operator formalism of multi-pole Virasoro algebra on Riemann sphere.** Chang Zhe (Academia Sinica, Beijing, BJ (China). Inst. of Theoretical Physics); Shen Jianmin; Guo Hanying; Xu Kaiwen; Wang Shikun; Wu Ke. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 11p. Order Number DE90627217. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

It is shown that the multi-pole Virasoro algebra on Riemann sphere can be obtained from operator product expansion of the stress-energy tensors in conformal field theory with modified definition of the vacua and other states and the BRST formalism of the algebra can also be constructed. The implications of the symmetry in string theory and in conformal theory are briefly mentioned. (author). 7 refs.

33499 (IC–90/21) **Total cross section of highly excited strings.** Lizzi, F.; Senda, I. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 8p. Order Number DE90627218. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The unpolarized total cross section for the joining of two highly excited strings is calculated. The calculation is performed by taking the average overall states in the given excitation levels of the initial strings. We find that the total cross section grows with the energy and momentum of the initial states. (author). 8 refs, 1 fig.

33500 (IC–90/22) **Introductory lectures on conformal field theory and strings.** Randjbar-Daemi, S.; Strathdee, J. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 78p. Order Number DE90627219. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The aim of these lectures is to provide an introduction to a first quantized formulation of string theory. This amounts to developing a consistent set of prescriptions for the perturbative computation of on-shell string amplitudes. The principal tool in this development is 2-dimensional conformal field theory on oriented manifolds of finite genus without boundaries (we treat only closed strings). This class of theory is much simpler than 4-dimensional quantum gravity with which it has many similarities. The geometry is not dynamical in this case, and the matter fields are not sensitive to local features of the geometry but only to global properties which can be characterized by a finite set of parameters (moduli). This can be formulated as field theory on a Riemann surface. We specialize mainly to free field theories for which the quantization problem can be completely solved by elementary means. An introduction to the general case will be given in Lectures II and III where the algebraic approach is discussed. The mathematics of Riemann surfaces is a well developed subject whose formalism is reviewed along with some of the principal theorems in Lecture IV. Physical string states are realized in the Hilbert space of a conformal field theory by the action of so-called "vertex operators" on the field theory vacuum state. Correlation functions of these vertex operators serve as ingredients for the computation of string amplitudes. They are to be integrated so as to include the contributions of all conformally inequivalent geometries, and a further manipulation (the GSO projection) is to be performed. These steps are to be regarded as part of the string prescription. The are introduced ad hoc to meet invariance and

unitarity requirements. However, in these introductory lectures we give a description only of the integration over geometries (Lecture VII). (Abstract Truncated)

33501 (IC–90/33) **On a phase structure of a three-dimensional ϕ^4 field theory.** Efimov, G.V. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 18p. Order Number DE90627220. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Two models of a scalar field ϕ with the interaction Lagrangians $g\phi^4$ and $g(\phi^2-\phi_0^2)^2$ are considered in R^3. There are phase transitions in these models for a certain $g=g_c$. In the first model $g\phi^4$ the symmetry $\phi \rightarrow -\phi$ keeps for any values of g. In the second model where the spontaneous breaking symmetry takes place for small g the symmetry $\phi \rightarrow -\phi$ is restored for $g>g_c$. The effective perturbation coupling constant is small in both cases. (author). 4 refs, 3 figs, 1 tab.

33502 (IC–90/41) **Classical extended conformal symmetries.** Viswanathan, R. International Centre for Theoretical Physics, Trieste (Italy). Feb 1990. 15p. Order Number DE90627221. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Extensions of the Virasoro algebra are constructed as Poisson brackets of higher spin fields which appear as coefficient fields in certain covariant derivative operators of order N. These differential operators are constructed so as to be covariant under reparametrizations on fields of definite conformal dimension. Factorization of such an N-th order operator in terms of first order operators, together with the inclusion of a spin one U(1) current, is shown to lead to a two-parameter W-algebra. One of these parameters plays the role of interpolating between W-algebras based on different Lie algebras of the same rank. (author). 11 refs.

33503 (IFT-P–03/89) **Chiral symmetry breaking in QED_3: bifurcation of the fermionic self-energy.** Almeida, L.D.; Natale, A.A. Instituto de Fisica Teorica (IFT), Sao Paulo, SP (Brazil). 1989. 10p. Order Number DE90627224. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The existence of a bifurcation point in the Scwinger-Dyson equation of 2+1 dimensional quantum electrodynamics with N fermions, is studied. It is found an evidence for the existence of a critical behavior, such that chiral symmetry breaking may occur only for a small number of flavors. (author).

33504 (KFKI–1989-45/A) **Gauge-invariant, nonperturbative approach to the infrared-finite bound-state problem in QCD.** Gogokhia, V.Sh. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Sep 1989. 25p. Order Number DE90627226. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Phys. Lett., B (NL).

Gauge invariant, nonperturbative approach to the bound state problem within the infrared finite Bethe-Salpeter equation is presented. Condition of cancellation of the nonperturbative infrared divergences is derived. Solutions for the quark propagator and corresponding quark gluon vertex function are written down which can be directly applied to the Bethe-Salpeter equation, in particular to the 'generalized ladder' approximation of this equation. (author) 18 refs.; 3 figs.

33505 (LAPP-TH–240-89) **Cancellation of infrared and mass singularities in the thermal di-lepton rate.** Altherr, T.; Becherrawy, T. Grenoble-1 Univ., 74 - Annecy (France). Lab. de Physique des Particules Elementaires. Mar 1989. 18p. Order Number DE90792998. Available from NTIS (US Sales Only), PC A03/MF A01.

We give a rigorous proof that, at first order in α_s, the thermal di-lepton rate is free of infrared and mass singularities. The calculation is performed for massive quarks in the real-time formalism with the n-dimensional regularization scheme. The cancellation is shown to occur within each topology.

33506 (LBL–28753) **Fermion loops in the effective potential of N = 1 supergravity, with application to no-scale models.** Burton, J.W. Lawrence Berkeley Lab., CA (USA). 27 Mar 1990. 70p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (UCB-PTH–90/09). Order Number DE90011215. Available from NTIS, PC A03/MF A01; OSTI; INIS.

Powerful and quite general arguments suggest that N = 1 supergravity, and in particular the superstring-inspired no-scale models, may describe the physics of the four-dimensional vacuum at energy densities below the Planck scale. These models are not renormalizable, since they arise as effective theories after the large masses have been integrated out of the fundamental theory; thus, they have divergences in their loop amplitudes that must be regulated by imposing a cutoff. Before physics at experimental energies can be extracted from these models, the true vacuum state or states must be identified: at tree level, the ground states of the effective theories are highly degenerate. Radiative corrections at the one-loop level have been shown to break the degeneracy sufficiently to identify the states of vanishing vacuum energy. As the concluding step in a program to calculate these corrections within a self-consistent cutoff prescription, all fermionic one-loop divergent corrections to the scalar effective potential are evaluated. (The corresponding bosonic contributions have been found elsewhere.) The total effective scalar Lagrange density for N = 1 supergravity is written down, and comments are made about cancellations between the fermionic and bosonic loops. Finally, the result is specialized to a toy no-scale model with a single generation of matter fields, and prospects for eventual phenomenological constraints on theories of this type are briefly discussed. 48 refs.

33507 (NBI-HE–90-05) **Electroweak BAU generation on the lattice: Real time vs. Euclidean approach.** Grigoriev, D.Yu. (AN SSSR, Moscow. Inst. Yadernykh Issledovanij (USSR)); Shaposhnikov, M.E. Niels Bohr Inst., Copenhagen (Denmark). Jan 1990. 14p. Order Number DE90625294. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We discuss possible approaches to investigation of anomalous processes with fermion number non-conservation occurring in hot early Universe. A real-time numerical technique for studying the ground state of gauge theories at high temperatures is developed. This problem is relevant to the scenario of electroweak BAU generation and some other topics. We present the results of real-time simulations of abelian Higgs model in (1+1) dimensions. (orig.).

33508 (NORDITA–89/51-P(prepr.)) **String theory of Calabi-Yau compactifications.** Luetken, C.A. Nordisk Inst. for Teoretisk Atomfysik, Copenhagen (Denmark). 1989. 58p. (CONF-8909327–: 13. international school of theoretical physics: Standard model and beyond, Szczyrk (Poland), 19-26 Sep 1989). Order Number DE90625297. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The conformal field theory description of Calabi-Yau compactifications of the heterotic superstring from 10 to 4 dimensions is outlined. The basic ideas of ordinary (bosonic) conformal field theory are explained before describing the exactly solvable N=2 superconformal minimal models which are needed in the tensor construction of certain particularly simple string vacua. Using a simple sigma-model construction of algebraic varieties and drawing on insight gained from the Landau-Ginzburg description of critical phenomena, it is explained how the critical behaviour of these 2-dimensional solvable quantum field theories with complex supersymmetry may be regarded as string compactification on a Calabi-Yau background. The virtue of this is to provide a tool for computing exact (tree level) results for strings in these highly nontrivial vacua, including all the Yukawa couplings needed in the construction of the low-energy effective field theory. (orig.).

33509 (NORDITA–89/59-P(prepr.)) **The sewing technique for strings and conformal field theories.** Di Vecchia, P. Nordisk Inst. for Teoretisk Atomfysik, Copenhagen (Denmark). 1989. 20p. (CONF-8911164–: 1989 superstrings workshop, Tuscaloosa, AL (USA), 8-11 Nov 1989). Order Number DE90627227. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We discuss recent results obtained from the sewing procedure for strings and conformal field theories. They are summarized by the N Point [String] g loop Vertex $V_{N;g}$, that is the 'generating functional' of all correlation functions [scattering amplitudes] of the theory on a genus g Riemann surface. We discuss $V_{N;g}$ for free bosonic theory with arbitrary background charge and for fermionic and bosonic bc systems. By saturating those vertices with highest

weight states we obtain in a simple way the correlation functions of the corresponding primary fields on genus g Riemann surfaces that reproduce known results including the correlation functions of a bosonic bc system, that present a number of peculiarities. We construct also V_{Ng} for the bosonic and fermionic string. In particular this technique allows one to explicitly construct the measure of integration over the moduli and to study the various pinching limits in order to check the finiteness of superstring theories. (orig.).

33510 (PCCF-T-88-12) **Relativistic calculation, in quantum electrodynamic, of the Compton diffusion on a bound electron.** Al. Saleh-Mahrousseh, S. Clermont-Ferrand-2 Univ., 63 - Aubiere (France). 1988. 214p. (In French). Order Number DE90792881. Available from NTIS (US Sales Only), PC A10/MF A01.

In order to explain Compton-peak displacement and broadening, when the incident photon energy is close to the electron binding energy, it is shown that a realistic calculation must include not only the binding and electron movement, but also the core participation, as a third parameter in the quadri-impulse conservation, in both initial and final states. A general equation giving the variation of the photon wavelength is deduced, taking into account all the variation sources and previous studies as limiting cases. It is shown that all the kinematical variables related to the primary electron must be analyzed in a relativistic way, for the deep atomic layers having high atomic number. An equation giving the mean square value of the atomic-electron momentum, which is true for whatever the electron state, is shown. Among the useful wave functions, a general equation for the radial functions of the atomic electrons is given. The applied propagator can explain the intermediate states describing an electron in a Coulombian field. A complete calculation of the covariant-matrice element and cross sections is accomplished. The final equations do not need any integration, except the ponderations related to an angle that is not experimentally accessible. This equation is shown in a computer program form.

33511 Non-linear σ-models and string theories. Sen, A. (Stanford Linear Accelerator Center, Stanford Univ., Stanford, CA (US)). 71-99 of Superstrings, unified theories and cosmology. Furlan, G.; Jengo, R.; Pati, J.C.; Sciama, D.W.; Sezgin, E.; Shafi, Q. World Scientific Pub. Co., Teaneck, NJ (USA) (1987). DOE Contract AC03-76SF00515. (CONF-8606312--: Summer workshop on superstrings, unified theories and cosmology, Trieste (Italy), 30 Jun - 15 aug 1986).

Various applications of non-linear σ-models to string theories are discussed. The author discusses the connection between σ-models and string theories, and shows how the σ-models can be used as important tools to prove various results in string theories. This paper contains a brief introduction to closed bosonic string theory in the light cone gauge. The author discusses closed bosonic string theory in the presence of massless background fields. The author uses the light-cone gauge and shows that in order to obtain a Lorentz invariant theory, the string theory in the presence of background fields must be described by a two dimensional conformally invariant theory. This in turn gives some constraints on the background fields which turn out to be the equations of motion of the string theory. This paper contains the extension of this analysis to the case of the heterotic string theory and the superstring theory in the presence of the massless background fields. The author shows how to use these results to obtain nontrivial solutions to the string field equations. This paper includes another application of these results, namely to prove that the effective cosmological constant after compactification vanishes as a consequence of the classical equations of motion of the string theory.

33512 Baryon-symmetric baryogenesis. Dodelson, S. (Gordon McKay Lab, Harvard University, Cambridge, Massachusetts 02138 (US)); Widrow, L.M. *Physical Review Letters (USA),* 64(4): 340-343 (22 Jan 1990). DOE Contract FG02-84ER40158.

We propose a new scenario of baryogenesis in which baryon number is an exact symmetry of the fundamental Lagrangian. If the global U(1) symmetry associated with baryon number is spontaneously broken at early times (when the temperature was of order 1–100 GeV) then the out-of-equilibrium decay of baryonic scalar particles can yield a cosmic baryon asymmetry in ordinary matter. This baryon number is exactly compensated by antibaryon number in the vacuum. At low temperatures, the symmetry is restored, and the antibaryons show up as neutral (antibaryonic) scalar particles or as nontopological solitons.

33513 External sources for topologically massive gauge fields. Wudka, J. (Physics Department, University of California at Davis, Davis, California 95616 (US)); Diaz-Cruz, J.L. *Physical Review, D (Particles Fields) (USA),* 41(2): 581-592 (15 Jan 1990).

We consider the finite-action classical solutions of Euclidean topologically massive gauge theories in the presence of external sources. We study the Abelian case for general sources, as well as the general non-Abelian case for weak sources. We also investigate the solutions within the radial *Ansatz*, both with the usual source coupling and with coupling to gauge-invariant sources. We show that all these solutions correspond to saddle points of the action.

33514 Fermions at high temperature. Gatoff, G. (Division de Physique Theorique, Institut de Physique Nucleaire, F-91406 Orsay CEDEX, France (FR)); Kapusta, J. *Physical Review, D (Particles Fields) (USA),* 41(2): 611-621 (15 Jan 1990). DOE Contract FG02-87ER40328.

We calculate the self-energy of massless fermions interacting with massless bosons at high temperature by summing the set of ring diagrams. This leads to an effective one-loop equation. We further approximate the boson self-energy by a temperature-dependent mass squared which is of order $(gT)^2$. At low momenta, $p<g^2T$, the fermion dispersion relation is $\omega=(1/3)p$, whereas for high momenta, $p>gT$, it is $\omega=p$. In the intermediate region, $g^2T<p<gT$, the fermion oscillations are overdamped and do not propagate. We speculate that this may be due to spatial inhomogeneities caused by the formation of resonant or coherent states of bosons and fermions, which have a characteristic size of $1/gT$ and a characteristic separation of $1/g^2T$.

33515 "Topological" (Chern-Simons) quantum mechanics. Dunne, G.V. (Center for Theoretical Physics, Cambridge, Massachusetts (USA)); Jackiw, R.; Trugenberger, C.A. *Physical Review, D (Particles Fields) (USA),* 41(2): 661-666 (15 Jan 1990). DOE Contract AC02-76ER03069.

We construct quantum-mechanical models that are analogs of three-dimensional, topologically massive as well as Chern-Simons gauge-field theories, and we study the phase-space reductive limiting procedure that takes the former to the latter. The zero-point spectra of operators behave discontinuously in the limit, as a consequence of a nonperturbative quantum-mechanical anomaly. The nature of the limit for wave functions depends on the representation, but is always such that normalization is preserved.

33516 QCD thermodynamics with eight time slices. Gottlieb, S. (Department of Physics, Indiana University, Bloomington, Indiana 47405 (US)); Liu, W.; Renken, R.L.; Sugar, R.L. *Physical Review, D (Particles Fields) (USA),* 41(2): 622-625 (15 Jan 1990). DOE Contract AC02-84ER40125;FC05-85ER25000;FG02-85ER40213.

Preliminary simulations of lattice QCD with two flavors of Kogut-Susskind quarks with masses of $0.025a^{-1}$ and $0.0125a^{-1}$ locate the expected crossover from the low-temperature regime of ordinary hadronic matter to the high-temperature chiral-symmetric regime. These calculations are insufficient to distinguish between a rapid crossover and a true phase transition.

33517 Approximate computation of the small-fluctuation determinant around a sphaleron. Carson, L. (Theoretical Physics Institute, University of Minnesota, 116 Church Street, Minneapolis, Minnesota 55455 (USA)); McLerran, L. *Physical Review, D (Particles Fields) (USA),* 41(2): 647-660 (15 Jan 1990). DOE Contract AC02-83ER40105;FG02-87ER40328.

We compute, in the high-temperature limit, the determinant of small fluctuations around the sphaleron configuration of electroweak theory using the approximate method of Diakonov, Petrov, and Yung. For the ratio λ/g^2 of scalar four-point coupling λ to gauge coupling g^2 near unity, we find that the determinant is of order one in agreement with previous computations. For λ/g^2 large corresponding to a strongly coupled Higgs phase, or for λ/g^2 very small tending to the Coleman-Weinberg limit, we find that the determinant strongly suppresses the rate of baryon-number-changing processes.

33518 Wormhole solution in coupled Yang-Mills–axion system. Das, A. (Department of Physics, University of Rochester, Rochester, New York 14627 (USA)); Maharana, J. *Physical Review, D (Particles Fields) (USA),* 41(2): 699-701 (15 Jan 1990). DOE Contract AC02-76ER13065.

We show that wormhole solutions arise naturally in the effective action, resulting from a heterotic string theory, in which Einstein gravity is coupled to the antisymmetric tensor and an SU(2) Yang-Mills field. The Peccei-Quinn scale in this case gets related to the string tension which is natural in any string compactification.

33519 Comment on anomaly cancellation in the standard model. Minahan, J.A. (Department of Physics, University of Florida, Gainesville, Florida 32611 (USA)); Ramond, P.; Warner, R.C. *Physical Review, D (Particles Fields) (USA),* 41(2): 715-716 (15 Jan 1990). DOE Contract FG05-86ER40272.

We review the arguments of anomaly cancellation in the standard model and point out that charge quantization is implied without reference to grand unification. In the absence of any reference to Higgs particles, anomaly cancellation, including the mixed gravitational anomaly, among the standard-model fermions yields two possible hypercharge assignments, one of which is the standard one. The uniqueness of the hypercharge assignments is recovered by extending the standard-model fermions by a right-handed neutrino and enlarging the gauge group to $SU(2)_L \times SU(2)_R \times U(1)$.

33520 Open superstrings in four dimensions. Bern, Z. (Theoretical Division, MS-B285, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)); Dunbar, D.C. *Physical Review Letters (USA),* 64(8): 827-830 (19 Feb 1990).

We outline the construction of $D=4$ type-I superstrings in the fermionic formulation. Two models are presented as examples, one of which is space-time supersymmetric and finite at the one-loop level.

33521 Ten-dimensional Lovelock-type space-times. Demaret, J. (Institut d'Astrophysique, Universite de Liege, B-4200 Cointe-Ougree, (Belgium)); Caprasse, H.; Moussiaux, A.; Tombal, P.; Papadopoulos, D. *Physical Review, D (Particles Fields) (USA),* 41(4): 1163-1171 (15 Feb 1990).

The correct field equations for several ten-dimensional Lovelock-type Lagrangians including terms up to fourth order in the curvature are given. They were deduced from a program which exploits the facilities of the differential package EXCALC. A first discussion of the obtained equations is presented. The justification of a conjecture made recently by Deruelle is given. Possible extensions of some previously obtained solutions of the field equations restricted to quadratic and cubic contributions are discussed. Finally, some errors in the existing literature are pointed out.

33522 Non-Abelian gauge theory on a finite-element lattice. Milton, K.A. (Department of Physics, The Ohio State University, Columbus, Ohio 43210 (USA)— Department of Physics and Astronomy, The University of Oklahoma, Norman, Oklahoma 73019 (USA)); Grose, T. *Physical Review, D (Particles Fields) (USA),* 41(4): 1261-1268 (15 Feb 1990).

We formulate the equations of motion of a non-Abelian gauge field coupled to fermions on a finite-element lattice. This is done by a straightforward iterative approach, in which successive interaction terms are added to the Dirac and Yang-Mills equations of motion, and to the field strength, in order to preserve gauge invariance, yielding a series in powers of ghA. Here g is the coupling constant, h is the lattice spacing, and A is the gauge potential. A simple, nonlocal, iterative formula is obtained for the interaction terms in the equations of motion. Difference equations which are satisfied by the full interaction terms are derived. On the other hand, the field strength is expressed locally in terms of the potential, in terms of nested commutators. The transformations of the gauge potentials are similarly determined to be series of nested commutators.

33523 Convergence of the Langevin simulation for complex Gaussian integrals. Haymaker, R.W. (Department of Physics—Department of Astronomy, Louisiana State University, Baton Rouge, Louisiana 70803 (USA)); Peng, Y. *Physical Review, D (Particles Fields) (USA),* 41(4): 1269-1275 (15 Feb 1990). DOE Contract AS05-77ER05490.

We solve the two-variable Fokker-Planck equation for the real probability distribution generated by the complex Langevin equation for a complex Gaussian integral. We find the eigenvalues, eigenvectors, and time-dependent behavior.

33524 Limits on a Lorentz- and parity-violating modification of electrodynamics. Carroll, S.M. (Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts 02138 (USA)); Field, G.B.; Jackiw, R. *Physical Review, D (Particles Fields) (USA),* 41(4): 1231-1240 (15 Feb 1990). DOE Contract AC02-76ER03069.

The Chern-Simons Lagrangian has been studied previously in (2+1)-dimensional spacetime, where it is both gauge and Lorentz invariant. In 3+1 dimensions, this term couples the dual electromagnetic tensor to an external four-vector. If we take this four-vector to be fixed, the term is gauge invariant but not Lorentz invariant. In this paper, we examine both the theoretical consequences of such a modification and observational limits we can put on its magnitude. The Chern-Simons term would rotate the plane of polarization of radiation from distant galaxies, an effect which is not observed. From the observations we deduce that the magnitude of the vector is $<1.7\times10^{-42}h_0$ GeV, where h_0 is the Hubble constant in units of 100 km sec^{-1} Mpc^{-1}.

33525 Nonperturbative QED and loop bremsstrahlung of neutral lepton pairs in heavy-ion collisions. Fried, H.M. (Physics Department, Brown University, Providence, Rhode Island 02912 (USA)); Cho, H. *Physical Review, D (Particles Fields) (USA),* 41(5): 1489-1495 (1 Mar 1990). DOE Contract AC02-76ER03130.

A simplified model of an eikonal representation for the scattering of high-Z ions is formulated, involving an IR approximation to closed fermion loops which themselves carry full radiative corrections. Signals are found for the possible production of "resonances" from such a loop when the impact-parameter-dependent electric field between the ions reaches successive thresholds on the order of $m^2c^{5/2}h^{-3/2}$. Qualitative arguments are given leading to narrow widths (~30 keV) and a prediction of peak energies in reasonable agreement with the data. An explicit enhancement factor, arising from the computation of low-frequency radiative corrections across the loop in the presence of a sufficiently strong external field, compensates the smallness of the fine-structure constant.

33526 Nonperturbative self-consistent unitary loop corrections to Skyrmion masses. Balazs, L.A.P. (Department of Physics, Purdue University, West Lafayette, Indiana 47907 (USA)). *Physical Review, D (Particles Fields) (USA),* 41(5): 1702-1705 (1 Mar 1990).

Quantum chromodynamics (QCD) effectively reduces to a nonlinear meson theory in the color-number $N_c \to \infty$ limit. The nucleon and Δ masses arising as solitons from such a theory usually turn out to be too large if phenomenological values are used for the meson parameters. Within a static-baryon approximation, however, we find that soft nonperturbative self-consistent unitary hadron-loop corrections (corresponding to quark-loop higher-$1/N_c$ orders in QCD) can lower these masses by the kind of magnitude needed to make them consistent with experiment, whereas a first-order $1/N_c$ correction is much smaller.

65 PHYSICS II

6510 Nuclear Physics

Refer also to citation(s) 33400, 33401, 33572

33527 (CBPF-NF–031/86) **An experimental study of the A-dependence of J/psi photoproduction.** Sokoloff, M.D. (and others); Anjos, J.C.C. dos; Appel, J.A. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1986. 14p. Order Number DE90627686. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In an experiment using the Tagged Photon Spectrometer at Fermilab, the photoproduction of J/psi mesons on hydrogen, beryllium, iron, and lead targets at a mean photon energy of 120 GeV was studied. The P^2_T spectra were used to separate the coherent diffractive signals from the incoherent signals. The per nucleus

cross-sections in terms of power law dependences, A^{α} were parameterized. For a sample of approximately 2100 $\psi \rightarrow \mu^+\mu^-$ events with $E_{\psi} > 80$ GeV it is that $\alpha = 1.40 \pm 0.06 \pm 0.04$ for the coherent diffractive signals and that $\alpha = 0.94 \pm 0.02 \pm 0.03$ for the incoherent signals. (author).

33528 (GSI–90-03a) **Supplement to the report of the Expert Committee 'Nuclear Physics and Heavy-Ion Research' 1986-1988/89.** Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Feb 1990. 191p. (In German). Order Number DE90792295. Available from NTIS (US Sales Only), PC A09/MF A01.

In the supplement to the scientific report of sponsoring project of the Federal Ministry for Research and Technology 'Nuclear Physics and Heavy-Ion Research' the publications are collected, which have been published in the three years of the sponsoring in the single projects. Essentially only journal articles have been taken up in order to keep the extent of this list surveyable. The taking up of the manifold of dissertations, diploma theses, and talks was generally abandoned. (orig.).

33529 (ORNL/FTR–3613) **[NEANDC/NEACRP Task Force on Nuclear Data Evaluation Cooperation]: Foreign trip report, April 28, 1990–May 2, 1990.** Larson, D.C. Oak Ridge National Lab., TN (USA). 16 May 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90011309. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Representatives of nuclear data evaluation efforts in the United States, Europe, and Japan met to review organizational progress and working plans for the six subgroups in the Working Group on Evaluation Cooperation, under sponsorship of the NEANDC/NEACRP. The purpose is to encourage cooperative efforts on nuclear data evaluation problems of mutual concern to OECD Countries.

6511 Experimental Techniques

Refer also to citation(s) 33723

6512 Nuclear Properties and Reactions, A = 1-5, Experimental

Refer also to citation(s) 33444

6513 Nuclear Properties and Reactions, A = 6-19, Experimental

Refer also to citation(s) 33553, 33567

33530 (DOE/ER/40304–6) **Parity violating weak neutral current effects in elastic e-^{12}C scattering: Final report, August 15, 1987–May 14, 1989.** Lubell, M.S. City Coll., New York, NY (USA). Dept. of Physics. 25 Apr 1990. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER40304. Order Number DE90011185. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Recently we completed a measurement of the Poutry nonconservation (PNC) asymmetry in elastic e^{-12}scattering at the Bates Electron Accelerator Center in which we achieved a precision at the level of approximately 10^{-7}, and improvement of a factor of five beyond that of the best previous experimental result. Moreover, the asymmetry we determined, $A \equiv (\sigma_R - \sigma_L)/(\sigma_R + \sigma_L)$, where$\equiv_Rand\equiv_L$represent the differential cross sections for the scattering of electrons with right and left helicity respectively, unlike the quantities determined in many other PNC experiments, suffers no anmbiguity in the theoretical interpretation of its meaning, a result which follows from the spinless, isoscalar nature of the $^{-12}$C nucleus. These properties permit the relevant nuclear physics in the elastic e_{-12}C interaction to be described by a single form factor, which cancels precisely in the asymmetry given. This paper discusses this work.

33531 (INS–802) **Nuclear Landau-Zener promotion in the reactions of the system ^{13}C + ^{16}O → ^{12}C + ^{17}O.** Imanishi, B.; Misono, S.; Oertzen, W. von. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Dec 1989. 18p. Order Number DE90791105. Available from NTIS (US Sales Only), PC A03/MF A01.

Nucleon molecular-orbital model based on the coupled-reaction-channel theory is applied to the system $^{13}C + {}^{16}O \rightarrow {}^{12}C + {}^{17}O$. Landau-Zener radial coupling effects explain the backward enhancement of measured differential cross sections of the transfer reaction $^{13}C(^{16}O, {}^{17}O)^{12}C$. In the calculation for the fusion cross section an enhancement is observed at and below the barrier, which agrees with the experimental data. (author).

33532 Charged-particle multiplicities following pion absorption on ^{6}Li. Ransome, R.D. (Rutgers University, New Brunswick, New Jersey 08854 (US)); Cupps, V.R.; Dawson, S.; Fergerson, R.W.; Green, A.; Morris, C.L.; McGill, J.A.; Comfort, J.R.; Ritchie, B.G.; Tinsley, J. *Physical Review Letters (USA)*, 64(4): 372-375 (22 Jan 1990).

We have studied particle emission following π^+ absorption on ^{6}Li at T_{π}=150 MeV by using a large-solid-angle detector. We find an absorption cross section leading to two or more energetic protons in the final state to be 98±15 mb. We find that only about 65 mb can be explained as quasideuteron absorption.

33533 Search for radiative transitions in the hypernucleus $_{\Lambda}{}^{10}$B. Chrien, R.E. (Brookhaven National Laboratory, Upton, New York 11973 (USA)); Bart, S.; May, M.; Pile, P.H.; Sutter, R.J.; Barnes, P.; Bassalleck, B.; Eisenstein, R.; Franklin, G.; Grace, R. *Physical Review, C (Nuclear Physics) (USA)*, 41(3): 1062-1074 (Mar 1990).

A search for radiative transitions between 0.100 and 0.9 MeV from the *p*-shell hypernucleus $_{\Lambda}{}^{10}$B was undertaken. Of special interest are the *M*1 spin-flip transitions between members of the doublet formed by coupling an *s*-shell Λ hyperon to the nuclear core. No such transitions were observed in this energy range attributable to $_{\Lambda}{}^{10}$B. This negative result provides additional constraints on the parameters of the *p*-shell Λ-nucleon effective potential. Evidence is presented of the observation of a γ ray which may be attributed to either the hyperfragment $_{\Lambda}{}^{8}$Li or $_{\Lambda}{}^{8}$Be. A cross section for the exclusive reaction $^7Li(\pi,\pi')^7Li^*$ (E_x=478 keV) of 2.2±0.3 mb/sr was also obtained.

6514 Nuclear Properties and Reactions, A = 20-38, Experimental

33534 Energy dependence of fusion evaporation-residue cross sections in the ^{28}Si+^{28}Si reaction. Vineyard, M.F. (Department of Physics, University of Richmond, Richmond, Virginia 23173 (USA)); Bauer, J.S.; Gosdin, C.H.; Trotter, R.S.; Kovar, D.G.; Beck, C.; Henderson, D.J.; Janssens, R.V.F.; Wilkins, B.D.; Rosner, G. *Physical Review, C (Nuclear Physics) (USA)*, 41(3): 1005-1013 (Mar 1990). DOE Contract W-31109-ENG-38.

Velocity distributions of mass-identified evaporation residues produced in the ^{28}Si+^{28}Si reaction have been measured at bombarding energies of 174, 215, 240, 309, 397, and 452 MeV using time-of-flight techniques. These distributions were used to identify evaporation residues and to separate the complete-fusion and incomplete-fusion components. Angular distributions and total cross sections were extracted at all six bombarding energies. The complete-fusion evaporation-residue cross sections and the deduced critical angular momenta are compared with lower energy data and the predictions of existing models.

6515 Nuclear Properties and Reactions, A = 39-58, Experimental

33535 Observation of double isovector giant dipole resonances from pion double charge exchange. Mordechai, S. (Ben-Gurion University of the Negev, Beer-Sheva 84105, (Israel)); Fortune, H.T.; O'Donnell, J.M.; Liu, G.; Burlein, M.; Wuosmaa, A.H.; Greene, S.; Morris, C.L.; Auerbach, N.; Yoo, S.H. *Physical Review, C (Nuclear Physics) (USA)*, 41(1): 202-212 (Jan 1990).

We report the observation of double isovector giant dipole resonances in (π^+,π^-) and, for the first time, also in (π^-,π^+)

double-charge-exchange reactions at T_π=292 MeV. The resonances have been observed on nine targets covering a wide range of mass at Q values around ≈−50 MeV in (π^+,π^-), but at significantly lower energy (Q=−33.8 MeV) in the inverse reaction on ^{56}Fe. The centroid energies in both reactions are very close to the energies at which the ΔT_z=±2 double giant dipole (J^π=0$^+$,2$^+$,ΔT=2) states are expected to appear. Angular distributions have been measured for the (π^+,π^-) resonances on ^{40}Ca,^{56}, Fe, and ^{93}Nb and each is observed to have a quadrupole shape. Based on their energies, angular distributions, cross sections, and the comparison between the (π^+,π^-) and (π^-,π^+) data on ^{56}Fe, we identify the resonances as double giant dipole states (i.e. states arising from a charge-exchange dipole operator acting twice on the ground-state wave function). The data from the present and recent observations indicate that the newly discovered resonance is a general collective feature of all nuclei.

6516 Nuclear Properties and Reactions, A = 59-89, Experimental

33536 Double-beta decay. Moe, M.K.; Rosen, S.P. *Scientific American (USA),* 261(5): 48-55 (Nov 1989).

In a double-beta event, two neutrons decay simultaneouly into two protons, two beta rays (electrons) and two antineutrinos. Experimentalists are now searching for another form of double-beta decay, one that does not produce neutrinos or antineutrinos. If such an event is found, it could unravelone of nature's great mysteries: What, if anything, is the mass of the neutrino? According to the Standard Model, the neutrino accompanying a negative beta ray is the distinct antiparticle of the one accompanying a positive beta ray. The theories that go beyond the Standard Model and assign a mass to the neutrino, however, predict that the particle emitted with a negative beta ray should be the same as the one emitted with a positive ray. In other words, the neutrino would be its own antiparticle. How can we tell whether these predictions are right? Double-beta decay is the ideal process in which to seek an answer to this question. If the neutrino has mass and is its own antiparticle, then the neutrino emitted in the first stage of the process might be reaborbed in the second, yielding a form of decay in which no neutrinos materialize. 8 figs.

33537 Measurements of time delays for projectile-like fragments in the reaction ^{40}Ar+Ge at 44 MeV/nucleon. Gomez del Campo, J. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831 (USA)); Barrette, J.; Dayras, R.A.; Wieleczko, J.P.; Pollacco, E.C.; Saint-Laurent, F. *Physical Review, C (Nuclear Physics) (USA),* 41(1): 139-146 (Jan 1990). DOE Contract AC05-84OR21400.

Crystal-blocking angular distributions have been measured for projectile-like fragments produced in bombarding a 10-μm Ge crystal with a 1.76-GeV ^{40}Ar beam. Long time delays of the order of $(6–12)\times10^{-18}$ s were extracted and gave a direct indication of important evaporation effects. The measured times can be reproduced using a broad distribution of primary fragments of the type predicted by the abrasion model, but with excitation energies from 15 to 50 MeV, which are higher than predicted by the model. The measured times can also be reproduced assuming a narrow primary mass distribution with highly excited fragments having excitation energies of about 150 MeV.

33538 Three paths for intermediate-mass fragment formation at a near-onset excitation energy of 1.3 MeV/nucleon. Boger, J. (Department of Chemistry, State University of New York at Stony Brook, Stony Brook, New York 11794-3400 (USA)); Kox, S.; Auger, G.; Alexander, J.M.; Narayanan, A.; McMahan, M.A.; Moses, D.J.; Kaplan, M.; Gilfoyle, G.P. *Physical Review, C (Nuclear Physics) (USA),* 41(3): 801-805 (Mar 1990).

Intermediate mass fragments of $4\leq Z\leq17$ have been studied from the reaction 640 MeV ^{86}Kr+^{63}Cu. Inclusive energy and angular distribution measurements have been made as well as coincidence measurements with fissionlike fragments of $18\leq Z\leq40$. The coincidence configuration was such that two-body exit channels were excluded; nevertheless, heavy fragments were recorded both in plane and out of plane with respect to light fragments of $4\leq Z\leq10$. Three mechanisms have been identified for intermediate mass fragment production. The dominant pathway for all intermediate mass fragments is two-body breakup of fission or evaporationlike character. A second pathway for $Z\leq10$ is intermediate mass fragment ejection from the composite nucleus followed by sequential fission. The third path is simultaneous ternary breakup for $4\leq Z\leq9$ that resembles ternary alpha-accompanied fission at low energies.

6517 Nuclear Properties and Reactions, A = 90-149, Experimental

Refer also to citation(s) 33535

33539 (CBPF-NF–042/89) **Probability of ternary fission of ^{93}Nb and^{nat} Ag nuclei induced by 0.8-1.8 GeV photons.** Lima, D.A. de (Istituto Nazionale di Fisica Nucleare, Frascati (Italy). Lab. Nazionale di Frascati); Milomen, W.C.C.; Tavares, O.A.P. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 15p. Order Number DE90627729. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The yields of ternary fission of ^{93}Nb and^{nat} Ag nuclei induced by bremsstrahlung photons of 0.8, 1.0, 1.4 and 1.8 GeV end-point energies have been measured by using the 2 Π-forward geometry with thick target metal foils in contact with makrofol polycarbonate sheets as fission-track detectors. Absolute mean cross sections per photon in the range 0.8-1.8 GeV have been obtained as 0.3 ± 0.3 μb and 0.5 ± μb, respectively, for ^{93}Nb and^{nat}Ag nuclei. These correspond to a probability of ternary fission of approx. 10^{-5} for both nuclei. Results are discussed and compared with previous ternary fission data obtained for nuclei of A <or approx., 90. (author).

33540 (GSI–90-15(prepr.)) **Excitation-energy sharing in uranium induced dissipative collisions.** Beier, G. (Technische Univ. Muenchen, Garching (Germany, F.R.). Fakultaet fuer Physik); Friese, J.; Henning, W.; Kienle, P.; Koerner, H.J.; Wagner, W.; Mayer, W.A.; Mayer, W. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Mar 1990. 15p. Contract BMFT 06 TM 178. Available from Also published in Z. Phys., A: At. Nuclei (Jun 1990) v. 336(2) p. 217-222.

Strongly damped collisions were studied in uranium induced reactions on ^{110}Pd and ^{124}Sn target nuclei near the barrier. The excitation-energy splitting was deduced from binary reaction yields and those in which the heavy fragment undergoes sequential fission. For systems with $87\leq Z\leq95$ for the heavy fragment, the excitation energy is concentrated in the lighter nucleus, at best shared equally. The results indicate a non-equilibrated energy dissipation, and support nucleon exchange based on average single-particle strength functions as the underlying dissipation mechanism at the barrier. (orig.).

33541 (IFUSP-P–774) **Decay of ^{132}Cs and nuclear structure of ^{132}Xe.** Cruz, M.T.F. da; Goldman, I.D. Sao Paulo Univ., SP (Brazil). Inst. de Fisica. Feb 1989. 31p. Order Number DE90625914. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Gamma spectroscopy, coincidence and angular correlation experiments were performed, in an extensive study of ^{132}Cs decay. The population intensities of states in ^{132}Ba were measured, some upper limits were determined and the value of the transition to the 4_1^+ state of ^{132}Ba has drastically changed. A new gamma transition of 688 KeV was detected and located in the level scheme of ^{132}Xe. The angular correlation measurements were performed with a Ge(Li)-NaI(Tl) spectrometer and helped in choosing the spin value for the 1804 KeV state of ^{132}Xe. Kumar-Baranger-type calculations were performed for the ^{132}Xe fairly good results. The resulting potential energy surface for ^{132}Xe is very different from that of Gneuss and Greiner model, suggesting the need for any quadrupole moment measurement for this nucleus. (author).

33542 Intermediate mass fragment emission in the 161-MeV p+Ag reaction. Yennello, S.J. (Department of Chemistry, Indiana University, Bloomington, Indiana 47405 (USA)); Kwiatkowski, K.; Rose, S.; Woo, L.W.; Zhou, S.H.; Viola, V.E. *Physical Review, C (Nuclear Physics) (USA),* 41(1): 79-86 (Jan 1990). DOE Contract FG02-88ER40404.

Spectra, angular distributions, and cross sections have been measured for Z=3–12 fragments produced in the reaction of 161-MeV protons with a silver target. Nonequilibrium mechanisms dominate the fragment yields at forward angles and for low-Z ejectiles. Equilibrated emission is primarily responsible for fragments observed at backward angles, an effect which grows in importance with increasing fragment Z value. A power-law fit to the elemental cross section distributions yields an exponent τ=4.7, significantly larger than observed for higher-energy protons. These data are compared with the predictions of statistical decay, accreting source, and preequilibrium calculations.

33543 Meson-exchange enhancement of the first-forbidden $^{96}Y^g(0^-)\rightarrow{}^{96}Zr^g$ (0^+) β transition: β decay of the low-spin isomer of ^{96}Y. Mach, H. (Clark University, Worcester, Massachusetts 01610 (USA)); Warburton, E.K.; Gill, R.L.; Casten, R.F.; Becker, J.A. *Physical Review, C (Nuclear Physics) (USA),* 41(1): 226-242 (Jan 1990). DOE Contract AC02-79ER10493.

We have investigated the 0^- $^{96}Y^g$ β decay to the levels of ^{96}Zr. A detailed decay scheme comprised of 63 γ rays and 44 energy levels has been obtained from γ singles, γ multispectral scaling, and γ-γ and $E0$-γ coincidences. Q_β was measured using the β-γ coincidence technique, while absolute $E0$ and γ-ray intensities were obtained from singles conversion electron and γ-ray spectra measured at beam saturation. The high sensitivity of the study was aimed at investigating the β feeding of levels with excitation enegy above 4 MeV. Although most of the new levels were found in this region, their total β feeding was found to be below 0.6%. The first-forbidden β-decay rate for 0^- $^{96}Y^g\rightarrow 0^+$ $^{96}Zr^g$ has been calculated within the framework of the spherical shell model using a model space of $\pi(0f_{7/2},0f_{5/2},1p_{3/2},1p_{1/2},0g_{9/2},1p_{1/2},0g_{9/2})\nu(0g_{7/2},1d_{5/2},1d_{3/2},2s_{1/2})$ with limitations on the orbit occupancies. Additional evidence for meson enhancement of the timelike component of the axial current is obtained; the meson-exchange enhancement factor was found to be 1.75±0.30, where the uncertainty arises from the calculation.

33544 Monopole strength and shape coexistence in the $A\approx$100 mass region. Mach, H. (Brookhaven National Laboratory, Upton, New York 11973 (US)); Moszynski, M.; Gill, R.L.; Molnar, G.; Wohn, F.K.; Winger, J.A.; Hill, J.C. *Physical Review, C (Nuclear Physics) (USA),* 41(1): 350-353 (Jan 1990). DOE Contract AC02-79ER10493.

Half-lives of 5.60(15) and 1.58(4) ns were measured for the 0_2^+ levels in ^{100}Zr and ^{100}Mo, respectively, using a β-γ-γ fast timing method. Analysis of the revised $\rho(E0)$ systematics in the crucial $A\approx$100 region indicates that high values of $\rho(E0)$ do not by themselves imply strong configuration mixing between two coexisting states as presently assumed.

33545 Coexistence features in the spherical-deformed $A\approx$100 transition region: Picosecond lifetime measurements in ^{97}Sr, ^{97}Y, and ^{97}Zr. Buescher, M. (Brookhaven National Laboratory, Upton, New York 11973 (USA)— Institut fuer Kernphysik, Kernforschungsanlage Juelich G.m.b.H., D-5170 Juelich, Federal Republic of Germany); Casten, R.F.; Gill, R.L.; Schuhmann, R. *Physical Review, C (Nuclear Physics) (USA),* 41(3): 1115-1125 (Mar 1990). DOE Contract AC02-76CH00016;FG02-88ER40417;W-7405-ENG-82.

A recently developed technique for fast timing measurements using β-γ-γ coincidences with plastic, BaF_2 and Ge detectors, respectively, has been used to measure lifetimes in the range 5–1500 ps in the neutron-rich nuclei ^{97}Sr, ^{97}Y, and ^{97}Zr. The results for ^{97}Y are interpreted in terms of quadrupole vibrational excitations. For ^{97}Sr the experimental data suggest the coexistence of spherical/vibrational and deformed states and allow the extraction of mixing matrix elements between them. A quadrupole moment of $|Q_0|$=3.5(4) e b for the deformed states in ^{97}Sr has been deduced.

33546 Subnanosecond lifetime measurements in Y and Sr nuclei and the saturation of deformation near A=100. Mach, H. (Brookhaven National Laboratory, Upton, New York 11973 (USA)— Institute for Nuclear Studies, PL 05-400, Swierk-Otwock, Poland (PL)— Ames Laboratory, Iowa State University, Ames, Iowa 50011 (USA)); Wohn, F.K.; Moszynski, M.; Gill, R.L.; Casten, R.F *Physical Review, C (Nuclear Physics) (USA),* 41(3): 1141-1146 (Mar 1990). DOE Contract AC02-76CH00016.

Half-lives of 47(6) ps in ^{99}Y and 72(7) ps in ^{100}Y, measured by β-γ-γ coincidences, and intraband $M1/E2$ ratios give $M1$ strengths and g factors of the bands $\pi(5/2)[422]$ in ^{99}Y, $\nu(3/2)[411]$ in ^{99}Sr, and $\pi(5/2)[422]\nu(3/2)[411]$ in ^{100}Y. The results are in remarkable agreement with the simple picture of these nuclei as a deformed ^{98}Sr core plus one or two valence nucleons, thus indicating that the deformation saturates for $A\approx$100 Sr and Y nuclei. This "early" saturation can be explained in terms of valence Nilsson orbitals.

33547 Interacting-boson-fermion-fermion model description of $^{140}La_{83}$ and comparison with levels populated by beta decay and neutron capture. Meyer, R.A. (Division of High Energy and Nuclear Physics, U.S. Department of Energy, Washington, D.C. 20545 (USA)— Nuclear Chemistry Division, Lawrence Livermore National Laboratory, Livermore, California 94550 (USA)); Marsh, K.V.; Seyfarth, H.; Brant, S. *Physical Review, C (Nuclear Physics) (USA),* 41(3): 1172-1183 (Mar 1990). DOE Contract W-7405-ENG-48.

We have studied the levels of ^{140}La populated in the beta decay of ^{140}Ba by gamma-ray spectroscopy, which included Compton-suppression gamma-ray spectra of ^{140}Ba sources that were continuously eluted of the ^{140}La daughter activity using ion-exchange chromatographic techniques. The study of the gamma-ray deexcitation of the low-energy levels was completed by a measurement of the low-energy gamma-ray spectrum following thermal neutron capture on ^{139}La. Also, we have performed calculations using the interacting-boson-fermion-fermion model. When we compare the model predictions with the levels and their properties, which we have determined, we find better agreement than has been obtained using quasiparticle-vibrational models.

33548 High-spin structure of N=51 ^{96}Rh and ^{97}Pd: A shell-model study. Piel, W.F. Jr. (Physics Department, State University of New York at Stony Brook, Stony Brook, New York 11794 (USA)); Fossan, D.B.; Ma, R.; Paul, E.S.; Xu, N.; McGrory, J.B. *Physical Review, C (Nuclear Physics) (USA),* 41(3): 1223-1233 (Mar 1990).

High-spin states of isotonic ^{96}Rh and ^{97}Pd were studied by means of the ^{64}Zn(^{40}Ca, $\alpha 3p n\gamma$)^{96}Rh and ^{64}Zn(^{40}Ca, $\alpha 2p n\gamma$)^{97}Pd reactions, respectively, with E_{lab}=167 MeV. Levels up to 5.5 MeV with J^π=15$^+$ in ^{96}Rh were populated while levels in ^{97}Pd up to 7.5 MeV were found. The yrast $(21/2)^+$ level of ^{97}Pd was found to decay to a $(19/2)^+$ level, in contrast to the behavior of the lighter odd-A isotones. An attempt to measure lifetimes using a neutron-γ coincidence technique revealed no new isomers in either nuclide with $t_{1/2}\geq$5 ns. The discovery of two low-lying transitions of 125 keV in ^{96}Rh requires a slight revision of a recently reported value of its atomic mass as well as that of isobaric ^{96}Pd. The high-spin structure and the N=51 systematics, particularly the location of the $\nu g_{7/2}$ strength, are compared with the results of shell-model calculations.

6518 Nuclear Properties and Reactions, A = 150-189, Experimental

33549 Nucleon exchange properties of the E/A=8.5 MeV ^{74}Ge+^{165}Ho reaction. Planeta, R. (Department of Chemistry, Indiana University, Bloomington, Indiana 47405 (USA)); Kwiatkowski, K.; Zhou, S.H.; Viola, V.E.; Breuer, H.; McMahan, M.A.; Kehoe, W. *Physical Review, C (Nuclear Physics) (USA),* 41(3): 942-957 (Mar 1990).

Mass and charge distributions have been measured for damped projectile-like fragments in the reaction ^{74}Ge+^{165}Ho at 8.5 MeV per nucleon bombarding energy. Coincidences were measured between Z- and A-identified projectile-like fragments and angle-correlated heavy reaction partners in order to derive the primary mass distribution for projectile-like fragments. Centroids and variances of the primary and post-evaporative Z, N, and A distributions are presented. The evolution of the primary N and Z distributions as a function of energy loss is found to deviate from predictions of the nucleon exchange transport model.

33550 Heat partition in the E/A=8.5 MeV $^{74}Ge+^{165}Ho$ reaction. Kwiatkowski, K. (Department of Chemistry, Indiana University, Bloomington, Indiana 47405 (USA)); Planeta, R.; Zhou, S.H.; Viola, V.E.; Breuer, H.; McMahan, M.A. *Physical Review, C (Nuclear Physics) (USA),* 41(3): 958-972 (Mar 1990).

The excitation-energy distribution of projectilelike fragments formed in the E/A=8.5 MeV $^{74}Ge+^{165}Ho$ reaction has been obtained by applying a statistical evaporation calculation to the difference between primary fragment mass yields derived from kinematic coincidence measurements and directly measured yields. A gradual transition from approximate equipartition of excitation energy for small energy losses to a division that favors the targetlike fragment for highly damped events is observed, in agreement with previous measurements. For a given energy loss, heat partition is found to correlate with the direction of net nucleon transfer. The variances of the excitation-energy distributions are shown to increase monotonically as a function of energy loss. The average data are compared with predictions of the nucleon exchange transport model. The results suggest that energy-loss mechanisms in addition to nucleon exchange may be important in the early stages of the collision.

33551 Single-particle states in ^{151}Tm and ^{151}Er: Systematics of neutron states in N=83 nuclei. Akovali, Y.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831 (USA)); Toth, K.S.; Goodman, A.L.; Nitschke, J.M.; Wilmarth, P.A.; Moltz, D.M.; Rao, M.N.; Sousa, D.C. *Physical Review, C (Nuclear Physics) (USA),* 41(3): 1126-1140 (Mar 1990). DOE Contract AC05-84OR21400.

With the use of mass-separated sources, the β-decay properties of ^{151}Yb and ^{151}Tm were investigated. The $h_{11/2}$, $s_{1/2}$, $d_{3/2}$, $d_{5/2}$, and $g_{7/2}$ single-proton states in ^{151}Tm and the $f_{7/2}$, $h_{9/2}$, $p_{3/2}$, $i_{13/2}$, and probably the $p_{1/2}$ single-neutron states in ^{151}Er were identified. Systematics of neutron states in even-Z N=83 isotones are compared with predictions of spherical Hartree-Fock-Bogoliubov calculations.

6519 Nuclear Properties and Reactions, A = 190-219, Experimental

33552 (GSI–90-14(prepr.)) **Fragment emission in the reaction $^{40}Ar+^{197}Au$ at E/A=30 and 220 MeV.** Milkau, U.; Berdermann, E.; Hildenbrand, K.D.; Hubele, J.; Lynen, U.; Mueller, W.F.J.; Rabe, H.J.; Sann, H.; Stelzer, H.; Trautmann, W. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Mar 1990. 15p. (CONF-8911190–: Meeting of physicists within the SATURNE III project, Saclay (France), 23-24 Nov 1989). Order Number DE90792302. Available from NTIS (US Sales Only), PC A03/MF A01.

Inclusive cross sections of intermediate mass fragments (atomic number $Z \geq 3$) were measured for ^{40}Ar induced reactions on ^{197}Au at SARA (E/A = 30 MEV) and at Saturne (E/A = 220 MeV). The detection threshold of the employed detector telescopes was about 1 MeV per nucleon. A moving-source parametrization was applied to the data in order to obtain integrated cross sections and to deduce properties of the emitting system. The derived source parameters (intensities, Coulomb energies, source velocities, and slope parameters) as a function of Z allow a characterization of the studied reactions and a comparison to other systems. (orig.).

33553 (KFK–4691) **Coulomb-dissociation of 156 MeV ^{6}Li-projectiles.** Kiener, J. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Kernphysik; Tuebingen Univ. (Germany, F.R.). Fakultaet fuer Physik. Feb 1990. 104p. (In German). Order Number DE90792217. Available from NTIS (US Sales Only), PC A06/MF A01.

Coulomb-dissociation of light nuclear projectiles in the electric field of heavy target nuclei has been experimentally investigated as an alternative access to radiate capture cross sections at low relative energies of the fragments, which are of astrophysical interest. As a pilot experiment the break-up of 156 MeV ^{6}Li-projectiles at ^{208}Pb with small emission angles of the α-particle and deuteron fragments has been studied. Both fragments were coincidentally detected in the focal plane of a magnetic spectrograph at several reaction angles well below the experimentally determined grazing angle and with a relative angle between the fragments of 0deg-2deg. The measured triple differential cross sections cover relative energies from the astrophysically interesting values below 100 keV to above 710 keV where the resonant break-up proceeds through the first excited state of ^{6}Li. Elastic break-up events with the target nucleus staying in its ground state could be separated from other reaction paths due to the kinematically complete measurements. Calculations based on a simple Coulomb-dissociation theory with a B(E2)-value for the resonant break-up, known from other experiments and with values extracted from radiative capture data for the direct break-up are compared with the elastic break-up data. The good agreement in the absolute magnitude and the shape for the energy spectra of direct break-up and the angular distribution of the scattered ^{6}Li-nuclei from the resonant break-up gives evidence for the dominance of Coulomb break-up in the considered break-up reaction and underlines its possible application for extracting information on astrophysically interesting cross sections. (orig.).

33554 Heavy-ion Coulomb excitation and photon decay of the giant dipole resonance in ^{208}Pb. Beene, J.R. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831 (USA)); Bertrand, F.E.; Horen, D.J.; Auble, R.L.; Burks, B.L.; Gomez del Campo, J.; Halbert, M.L.; Sayer, R.O.; Mittig, W.; Schutz, Y. *Physical Review, C (Nuclear Physics) (USA),* 41(3): 920-932 (Mar 1990). DOE Contract AC05-84OR21400.

The excitation and electromagnetic decay of the giant resonance region (8–15 MeV) in ^{208}Pb have been measured with the $^{208}Pb(^{17}O,^{17}O')$ reaction at 84 MeV/nucleon. The study of coincidences between scattered ^{17}O ions and photon decays to the ^{208}Pb ground state, including angular correlations, serves to isolate the isovector giant dipole resonance and enable us to investigate the mechanisms of its excitation and decay in detail. The angular correlations and yields are accounted for quantitatively by a pure Coulomb excitation model of the reaction process. The distribution in energy of the ground-state photon decay cross section is well described by an approximate application of the multistep theory of nuclear reactions. The photon coincidence measurements enable us to extract the differential cross sections for the 10.6-MeV giant quadrupole and 13.9-MeV monopole resonances with low uncertainty. An analysis of the Coulomb-nuclear interference for the 10.6-MeV excitation indicates that the ratio of neutron to proton matrix elements, M_n/M_p, is 1.7±0.4, consistent with a predominantly isoscalar character for the giant quadrupole resonance.

33555 Changes in target fragmentation mechanisms with increasing projectile energy in intermediate energy nuclear collisions. Loveland, W. (Chemistry Department, Oregon State University, Corvallis, Oregon 97331 (USA)); Aleklett, K.; Sihver, L.; Xu, Z.; Casey, C.; Morrissey, D.J. *Physical Review, C (Nuclear Physics) (USA),* 41(3): 973-987 (Mar 1990). DOE Contract AM06-70RL02227.

We have measured the target fragment production cross sections and angular distributions for the interaction of 16 MeV/nucleon ^{32}S, 32 MeV/nucleon ^{40}Ar, and 44 MeV/nucleon ^{40}Ar with ^{197}Au. We have deduced the fragment isobaric yield distributions and moving frame angular distributions from these data. The fission cross sections decrease with increasing projectile energy and the heavy residue cross sections (which are much larger than previous counter measurements) increase. There is an unusual change in the fragment isobaric yield distributions in the reactions induced by 32 MeV/nucleon ^{40}Ar and 44 MeV/nucleon ^{40}Ar. We have used the symmetry properties of the moving frame distributions to show the relative time scale of the reaction mechanisms involved. The fission fragments associated with the peripheral collision peak in the folding angle distribution originate in a normal, slow fission process in which statistical equilibrium has been established. At the two lowest projectile energies, the fission fragments associated with the central collision peak in the folding angle distribution originate in part in fast, nonequilibrium processes. At the highest projectile energies, there are no fission fragments associated with high-momentum-transfer events. The intermediate mass fragments originate primarily in events in which statistical equilibrium has not been established.

33556 Coulomb-nuclear interference in pion inelastic scattering. Oakley, D.S. (University of Colorado, Boulder, Colorado

80309 (USA)); Kunz, P.D.; Morris, C.L. *Physical Review, C (Nuclear Physics) (USA)*, 41(3): 1081-1083 (Mar 1990).

The energy dependence of the cross sections for the first 2^+, 3^-, and 4^+ excitations in ^{208}Pb from pion inelastic scattering at incident pion energies from T_π=116 to 291 MeV is investigated. A significant signature of Coulomb-nuclear interference is observed in the π^-/π^+ cross-section ratio.

33557 **Analyzing powers for $\vec{p}$+^{208}Pb at large momentum transfers.** Moshi, M.G. (Department of Physics, University of California at Los Angeles, Los Angeles, California 90024 (USA)); Whitten, C.A. Jr.; Aas, B.; Igo, G.; Lopiano, D.; Ray, L.; Jones, K.; Gazzaly, M. *Physical Review, C (Nuclear Physics) (USA)*, 41(3): 1279-1281 (Mar 1990).

High quality analyzing power data ($\Delta A_y \leq 0.05$) for 800 MeV ^{208}Pb($\vec{p}$,p') scattering to the 0^+ ground state and to the 3^- 2.61 MeV collective state were obtained for $\theta_{c.m.}$=22° to 37°, extending the range of momentum transfer out to 4.7 fm^{-1}. Theoretical predictions for these data were obtained using analyses based on both a nonrelativistic impulse approximation approach and a relativistic impulse approximation approach. For both the elastic and inelastic analyzing powers, the relativistic impulse approximation approach provided a better description at these large momentum transfers.

33558 **Observation of superdeformation in ^{192}Hg.** Becker, J.A. (Lawrence Livermore National Laboratory, Livermore, California 94550 (USA)); Roy, N.; Henry, E.A.; Deleplanque, M.A.; Beausang, C.W.; Diamond, R.M.; Draper, J.E.; Stephens, F.S.; Cizewski, J.A.; Brinkman, M.J. *Physical Review, C (Nuclear Physics) (USA)*, 41(1): R9-R12 (Jan 1990). DOE Contract W-7405-ENG-48.

A γ-ray cascade in ^{192}Hg consisting of seventeen members is reported. The transition spacing is characteristic of a superdeformed band, and we propose it to be the second instance of superdeformation in the Hg region. We find the lowest spin in the band likely to be $8\hbar$ using a new method for obtaining spins in some superdeformed nuclei.

6520 Nuclear Properties and Reactions, A = 220 and Above, Experimental

Refer also to citation(s) 33543

33559 (GSI–90-13(prepr.)) **Transient times of fission in ^{40}Ar+^{232}Th peripheral collisions.** Eckert, E.M. (Frankfurt Univ. (Germany, F.R.)); Kuehmichel, A.; Pochodzalla, J.; Cerruti, C.; Lhenoret, P.; Lucas, R.; Mazur, C.; Ngo, C.; Ribrag, M.; Tomasi, E. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Mar 1990. 15p. Order Number DE90792308. Available from NTIS (US Sales Only), PC A03/MF A01.

Peripheral ^{40}Ar + ^{232}Th collisions at a bombarding energy E/A = 30 MeV were studied by measuring coincidences of fission fragments with projectile fragments detected near the grazing angle. It is found that the sequential fission of the highly excited target residue nuclei is severely hindered if their excitation energies, determined from the measured recoil momenta, exceed a value of about 50 to 75 MeV. A transient time of fission of the order of 10^{-20} s is deduced. (orig.).

33560 **A new resonance region evaluation of neutron cross sections for ^{235}U.** deSaussure, G. (Oak Ridge National Lab., TN (USA)); Leal, L.C.; Perez, R.B.; Larson, N.M.; Moore, M.S. *Nuclear Science and Engineering (USA)*, 103(2): 109-118 (Oct 1989). DOE Contract AC05-84OR21400.

A new evaluation of the resolved resonance range for the neutron cross sections of ^{235}U is described. Up to 110 eV, the evaluation is based on an R-matrix analysis of several fission, capture, and transmission measurements. Levels above 110 eV are no longer resolved so that many resonances are missed; from 110 to 500 eV, most of the important resonances can be identified and analyzed so that the cross section and transmission data are well represented by the proposed parameters. From 500 to 2250 eV, fictitious parameters are provided that describe fairly well the results of thick sample transmission measurements and recent fission cross-section data. Such a parameterization is likely to yield a better approximation of resonance self-shielding than the current ENDF/B-V unresolved resonance treatment.

33561 **Direct measurement of the branching ratio Γ_n/Γ_f of ^{238}U in inelastic alpha scattering in the giant resonance region.** Countryman, P.J. (Department of Physics, Stanford University, Stanford, CA (USA)— High Energy Physics Laboratory, Stanford University, Stanford, California 94305 (USA)); Griffioen, K.A.; Van Bibber, K.; Yearian, M.R.; Calarco, J.R. *Physical Review, C (Nuclear Physics) (USA)*, 41(3): 1039-1049 (Mar 1990). DOE Contract AM03-76SF00326.

We have directly measured, for the first time, the neutron-fission branching ratio, Γ_n/Γ_f, of an actinide nucleus (^{238}U) excited in inelastic scattering as a function of excitation energy. This was accomplished using a $\approx 4\pi$ array of fission counters to separate fission neutrons from decay neutrons in the simultaneous coincidence experiments $(\alpha,\alpha' f)$ and $(\alpha,\alpha' nf)$. The measured branching ratio agrees well with previous photoneutron data. In a separate experiment, we have measured the angular distribution of alpha particles scattered from ^{238}U in coincidence with fission decay $(\alpha,\alpha' f)$. This provides us with an estimate of the cross section (in the fission channel) for exciting the isosca- lar giant monopole and giant quadrupole resonances. This estimate, combined with the Γ_n/Γ_f measurement, allows us to place bounds on the neutron-fission branching ratio for the isoscalar giant monopole and giant quadrupole resonances themselves.

6530 Nuclear Theory

Refer also to citation(s) 33329, 33368, 33444, 33536, 33543, 33549, 33556, 33557, 33560, 33720

33562 (BNL–44522) **Physics of the pion liquid.** Shuryak, E.V. Brookhaven National Lab., Upton, NY (USA). Apr 1990. 45p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900331–7: Workshop on heavy ion physics at the alternating gradient synchrotron, Upton, NY (USA), 3-7 Mar 1990). Order Number DE90011001. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Excited hadronic matter in the temperature interval T = 100–200 MeV is not an ideal pion gas, but rather a liquid, in which attractive interaction among particles plays an important role. Pion dispersion curve is in this case essentially modified by a kind of collective momentum-dependent potential, which becomes important as the "quasipion" comes to the boundary of the system. We show that effects can provide and explanation for a number of recent experimental puzzles, in particular, for the observed copious production of soft pions and soft photons in high energy hadronic reactions. 31 refs., 13 figs.

33563 (BONN-ME–90-02) **Integrodifferential equation approach. Pt. 2. Triton and α-particle wave functions. Graphical plots.** Oehm, W. (Bonn Univ. (Germany, F.R.). Physikalisches Inst.); Sofianos, S.A.; Fiedeldey, H.; Fabre de la Ripelle, M. Bonn Univ. (Germany, F.R.). Physikalisches Inst. Mar 1990. 40p. Available from Bonn Univ. (Germany, F.R.). Physikalisches Inst.

Three- and four-nucleon ground state wave functions are displayed graphically in coordinate space as well as the Faddeev amplitudes from which they are constructed. In the four-body case only two-particle correlations are taken into account in the Integrodifferential Equation Approach, which consequently allows us to make a direct comparison between the Faddeev amplitudes for three and four nucleons and to demonstrate their surprising similarity in shape. We also investigate the effect of the inclusion of the hypercentral potential in the definition of the (modified) Faddeev amplitudes. It is shown that the Faddeev-type components calculated in the Adiabatic Approximation are rather similar in shape to those calculated by means of the exact solution of the system of coupled integro-differential equations in two variables. The mixed symmetry component of the Faddeev-type amplitudes show the greatest sensitivity to the number of nucleons, the inclusion of the Hypercentral Potential, and to the Adiabatic Approximation. (orig.).

33564 (CBPF-NF–024/89) **Effective fire-tube and geometric scaling in proton-proton and proton-antiproton collisions.** Nazareth, R.A.M.S. (Universidade Federal, Rio de Janeiro, RJ

(Brazil)); Prado, N.; Kodama, T. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 39p. Order Number DE90627591. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The simple phenomenological model for proton process is developed. The model combines a fireball formation process via string fragmentation mechanism for the space-time development of a non-pertubative fire-tube of excited vacuum, with a subsequent final hadron production through fireball decays. The effective string tension is proportional to the fire-tube transversal area determined by the overlap area of the two colliding protons. The overlap area is a function of the impact parameter and the proton-proton-total cross-section. An excellent agreement with experimental data is obtained for a wide energy range covering from $\sqrt{3} \approx 20$GeV to 1 TeV. (author).

33565 (CEA-CONF–9981) **Fission product measurement methods. Present state of knowledge.** Blachot, J. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (FR). Dept. de Recherche Fondamentale); Bocquet, J.P.; Brissot, R. CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Recherche Fondamentale. 1989. 10p. (In French). (CONF-8906325–: 50. Anniversary of Fission Discovery, Palaiseau (France), 21 Jun 1989). Order Number DE90792901. Available from NTIS (US Sales Only), PC A02/MF A01.

Latest state of development of nuclear charge and mass distributions in fission products is presented. A global view (still incomplete) is given using distribution variations in function of number of mass, atomic number and excitation energy of the fissioning nucleus.

33566 (CONF-881054–49) **Micropolyelectrons as possible sources of the anomalous positron peaks in heavy-ion reactions.** Wong, Cheuk-Yin. Oak Ridge National Lab., TN (USA). [1988]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. Order Number DE90010721. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We propose that aggregates of electrons and positrons in a small assembly [micropolyelectrons $(e^+e^-)^n$], held together by their own electromagnetic interactions, are probably the sources of the anomalous positron peaks observed in heavy-ion reactions. The quasistability of the micropolyelectrons arises from a strong non-central, short-range, attractive interaction between an electron and a positron in their 0^{++} state, which may be supercritical and may lead to a condensation of such pairs. These entities are strongly attracted to a nucleus with a large charge, due to the quadratic Coulomb interaction between the nucleus and the constituents, and may therefore have binding energies greater than their rest masses to render them spontaneously produced in a strong Coulomb field. Final-state interactions between the produced micropolyelectrons and the receding nuclei may lead to their being nearly at rest and back-to-back decay into e^+ and e^- in some cases, and their being captured into stationary orbits and asymmetrical decay in some other cases.

33567 (GANIL-T–89-01) **Theoretical and experimental aspects of the multiple fragmentation reactions in the nucleus-nucleus collisions at intermediate energies.** Cussol, D. Grand Accelerateur National d'Ions Lourds (GANIL), 14 - Caen (France); Caen Univ., 14 (France). May 1989. 110p. (In French). Order Number DE90793002. Available from NTIS (US Sales Only), PC A06/MF A01.

The multiple fragmentation phenemenon is observed in the nucleus-nucleus collisions, at intermediate energies. The experimental and theoretical investigation of the reaction mechanism, is performed. The process is theoretically described, by applying dynamical and fragmentation models. The dynamical phase simulation is carried out by means of the Landau-Vlasov calculations, which are performed up to the obtention of a low density system. A statistical fragmentation model is applied. The results show that a multiple fragmentation must occur at intermediate energies; and that the reaction threshold energy and properties are bound to the nuclear matter state equation. The evolution mechanisms of the Argon-on-Aluminum system experiment, from 25 to 85 MeV per nucleon, are analyzed. It allows both the collisions classification as a function of their impact parameter and the selection of the central collisions. The existence of the multiple fragmentation phenomenom is pointed out.

33568 (IC–89/433) **The relative probability for the recoilless Λ-production in nuclei in the plane wave impulse approximation.** Grypeos, M.E. (International Centre for Theoretical Physics, Trieste (Italy)); Lalazissis, G.A.; Massen, S.E.; Panos, C.P. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 15p. Order Number DE90627592. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The problem of the estimate of the relative probability P for the recoilless Λ-production in nuclei by means of the (K^-, π^-) reaction, is investigated in the plane wave impulse approximation. It is shown on the basis of this and certain other approximations that P may be given by a very simple expression, namely by a Gaussian of the momentum transfer q, in which the harmonic oscillator quantum number of the outer shell and the oscillator spacings and (reduced) masses of the Λ and the nucleon appear. The overlap integrals between the Λ and the nucleon wave functions are found to be close to unity and can usually be omitted in the expression for P. Numerical estimates of P are also made for a number of hypernuclei. (author). 35 refs, 1 tab.

33569 (IFT-P–30/89) **Nucleon and isobar properties in a relativistic Hartree-Fock calculation with vector Richardson potential and various radial forms for scalar mass terms.** Dey, J. (Maulana Azad Coll., Calcutta (India)); Dey, M.; Mukhopadhyay, G.; Samanta, B.C. Instituto de Fisica Teorica (IFT), Sao Paulo, SP (Brazil). 1989. 12p. Order Number DE90627537. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Mean field models of the nucleon and the delta are established with the two-quark vector Richardson potential along with various prescriptions for a running quark mass. This is taken to be a one-particle operator in the Dirac-Hartree Fock formalism. An effective density dependent one body potential $U(\rho)$ for quarks at a given density ρ inside the nucleon is derived. It shows an interesting structure. Asymptotic freedom and confinement properties are built-in at high and low densities in U (ρ) and the model dependence is restricted to the intermediate desnsities. (author).

33570 (IFUSP-P–792) **SAM revisited: absorptive uniform semiclassical approximation and application to heavy-ion elastic scattering.** Pato, M.P.; Hussein, M.S. Sao Paulo Univ., SP (Brazil). Inst. de Fisica. Jun 1989. 86p. Order Number DE90625825. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The Uniform Semiclassical Approximation is modified to take into account absorption. Symbol calculus and pseudodifferential operators techniques are employed for the purpose. The resulting theory, very similar to the one developed by Frahn and Gross permits the decomposition of the near-side and far-side amplitudes into diffractive and refractive components. Application to several heavy-ion systems at intermediate energies is made. (author).

33571 (INS–801) **Super-hypernuclei in the quark-shell model, 3.** Terazawa, Hidezumi. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Dec 1989. 12p. Order Number DE90791128. Available from NTIS (US Sales Only), PC A03/MF A01.

By following of the previous papers, a formalism for calculating nuclear masses in the quark-shell model of nuclei in quantum chromodynamics is presented, some general properties of nuclear masses are discussed and a crude estimate of the Hλ ('hex-alambda') mass is also made for illustration. (author).

33572 (IPNO-TH–88-45) **Isoscalar giant resonances in a relativistic model.** L'Huillier, M.; Nguyen Van Giai. Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire. Jul 1988. 32p. Order Number DE90792988. Available from NTIS (US Sales Only), PC A03/MF A01.

Isoscalar giant resonances in finite nuclei are studied in a relativistic Random Phase Approximation (RRPA) approach. The model is self-consistent in the sense that one set of coupling constants generates the Dirac-Hartree single-particle spectrum and the residual particle-hole interaction. The RRPA is used to calculate response functions of multipolarity L = 0,2,3, and 4 in light and medium nuclei. It is found that monopole and quadrupole modes

exhibit a collective character. The peak energies are overestimated, but not as much as one might think if the bulk properties (compression modulus, effective mass) were the only relevant quantities.

33573 (IPNO-TH-88-68) **The pion in the deuteron.** Ballot, J.L. (Paris-11 Univ., 91 - Orsay (FR). Inst. de Physique Nucleaires); Eiro, A.M.; Robilotta, M.R. Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire. Dec 1988. 29p. Order Number DE90792987. Available from NTIS (US Sales Only), PC A03/MF A01.

A potential containing the OPEP tail and regularized at the origin by means of three parameters is used to construct several families of deuterons, which are employed in the assessment of the influence of the inner parts of the potential over observables such as Y_m, η and Q. The off-energy shell extrapolation of the results is considered, so as to provide guide-lines for the treatment of other systems such as the triton. We also show that, provided the central potential contains an OPEP tail, the value of η is determined with great precision by just the inner part of the tensor component of the interaction.

33574 (ISN-89-37) **Entropy and Effective temperature in second RPA dynamics.** Jang, S. Grenoble-1 Univ., 38 (France). Inst. des Sciences Nucleaires. May 1989. 10p. (CONF-890543--: Spring meeting of the American Physical Society, Baltimore, MD (USA), 1-4 May 1989). Order Number DE90792924. Available from NTIS (US Sales Only), PC A02/MF A01.

The temporal behavior of the entropy and effective temperature of the system of collective RPA phonons is studied by deriving closed formulas of these quantities from the formulation based on the second RPA dynamics at finite temperature.

33575 (ISN-89-47) **Anharmonicities of vibrational motion in even-even deformed nuclei.** Piepenbring, R. Grenoble-1 Univ., 38 (France). Inst. des Sciences Nucleaires. May 1989. 10p. (CONF-8906168--: International conference on selected topics in nuclear structure, Dubna (USSR), 20-24 Jun 1989). Order Number DE90792923. Available from NTIS (US Sales Only), PC A02/MF A01.

The aim of the investigation is to compare; the description of some specific nonrotational states within the following theories: the quasiparticle phonon nuclear, the interacting boson and the Bohr-Mottelson. Special emphasis is given to the quasi-particle-phonon nuclear model and to the multiphonon method. The basic assumptions of the different models are given. Some examples are provided. The various microscopic theories treating properly the Paul principle's effect on nuclear vibrations show that it is not possible to obtain a compressed energy spectrum in realistic calculations. It is suggested to look for specific reactions, which are able to give experimental evidence of the low-lying two-phonon states and to check the accuracy of the different theoretical predictions.

33576 (KFKI-1989-40/A) **Fluid-dynamics of the nuclear surface Fermi-layer.** Bastrukov, S.I. (Eoetvoes Lorand Tudomanyegyetem, Budapest (Hungary). Atomfizikai Tanszek); Maruhn, J.A. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Sep 1989. 24p. Order Number DE90627590. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In the framework of the long-mean-free-path approach the fluid-dynamical model of the nuclear surface as a spherical Fermi-layer is formulated. It is shown that the model reproduces known results of Fermi-drop dynamics and permits the description of more low energy collective states in spherical nuclei. The quantum-capillary branch of low-lying surface excitations is predicted. The model gives an adequate description of both lowest and highest experimental collective energies. (author) 18 refs.; 8 figs.

33577 (LPN-89-01) **Nuclear dynamics with the finite range Gogny force.** Sebille, F.; Royer, G.; Gregoire, C.; Remaud, B.; Schuck, P.; La Mota, V. de; Raffray, Y. Paris-11 Univ., 91 - Orsay (France). Lab. de Physique Nucleaire et Hautes Energies. 1989. 21p. (CONF-8901120--: 27. international winter meeting on nuclear physics, Bormio (Italy), 23-27 Jan 1989). Order Number DE90792985. Available from NTIS (US Sales Only), PC A03/MF A01.

A semi-classical description of heavy ion is presented, it is based on the Landau-Vlasov equation and implemented with the Gogny force which generates momentum dependence through finite range exchange terms. The effects of momentum dependence on the dynamics, especially through collective flow observables, are studied in comparison with local forces.

33578 (LUND-MPh-89-06) **Diabatic orbitals in nuclear structure.** Bengtsson, Tord. Lund Inst. of Tech. (Sweden). Dept. of Mathematical Physics. Sep 1989. 16p. (CONF-890686--: International conference on new aspects of nuclear spectroscopy, Crete (Greece), 26 Jun - 1 jul 1989). Order Number DE90627568. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Invited talk at the Conference.

The importance of wavefunctions in detailed nuclear structure calculations is emphasized. A scheme to enable studies of the development of wavefunctions as the hamiltonian gradually changes is presented. By using this scheme, nuclear structure properties can be calculated with great detail. (author).

33579 **Multiconfiguration resonating-group theory of ^{8}Li.** Fujiwara, Y. (Theoretical Physics Institute, School of Physics, University of Minnesota, Minneapolis, Minnesota 55455 (USA)—Department of Physics, Kyoto University, Kyoto 606, (Japan)); Tang, Y.C. *Physical Review, C (Nuclear Physics) (USA),* 41(1): 28-44 (Jan 1990). DOE Contract AC02-79ER10364.

The nucleus ^{8}Li is studied with a multiconfiguration resonating-group calculation which consists of n+^{7}Li, t+^{5}He, n+^{7}Li*, and ^{4}H+α cluster configurations. With no adjustable parameters, the results show that the calculated level spectrum agrees well with experiment and with the empirical level spectrum obtained by Knox, Resler, and Lane using an extensive *R*-matrix analysis. A calculation employing only the n+^{7}Li configuration is found to be generally inadequate. Among the configurations t+^{5}He, n+^{7}Li*, and ^{4}H+α which are employed to enlarge the model space, the n+^{7}Li* configuration is shown to be the most important from an overall viewpoint. Comparisons between calculated and experimental scattering and reaction cross sections have also been made. Here one finds that the calculation explains all the main features of measured results. In particular, the triton production cross section of the ^{7}Li($n,n't$)α reaction is well reproduced. The calculated n+^{7}Li total reaction cross section turns out to be somewhat too small, being equal to around 75% of the experimental value.

33580 **Forward scattering of a proton from a J=1 nucleus: Selection rules for flipping the spin of the target by two units.** Zheng, D.C. (Department of Physics and Astronomy, Rutgers University, Piscataway, New Jersey 08855 (US)); Harrington, D.; Zamick, L. *Physical Review, C (Nuclear Physics) (USA),* 41(1): 75-78 (Jan 1990). DOE Contract FG05-86ER40299.

We show that in the plane-wave impulse approximation an incident proton cannot, in the case of elastic forward (q=0) scattering, change the polarization state (J,M) of a J=1 target nucleus from (1,+1) to (1,−1), where the direction of polarization is normal to the scattering plane. We then show that this double spin-flip process can take place when the effects of double scattering are taken into account. As a corollary, the spin-quadrupole moment of the deuteron must be zero.

33581 **Neutral pion photoproduction on the nucleon near threshold.** Nozawa, S. (TRIUMF, 4004 Wesbrook Mall, Vancouver, British Columbia, (Canada) V6T 2A3); Lee, T.H.; Blankleider, B. *Physical Review, C (Nuclear Physics) (USA),* 41(1): 213-220 (Jan 1990). DOE Contract W-31109-ENG-38.

Neutral pion photoproduction on the nucleon near threshold is investigated using a dynamical model. Analytic properties of the final-state interaction amplitude in the energy region near π^+n production threshold are examined in detail. It is shown that the commonly used procedure, based on an analytical continuation of the K matrix to the unphysical region, is not compatible to an approach incorporating full off-energy-shell dynamics. Our calculation indicates that the final-state interaction amplitude derived from a dynamical model could involve large cancellation between the different pion photoproduction mechanisms. This leads to the surprising result that the final-state interaction effect due to the intermediate π^0p state can be as important as that due to the π^+n

intermediate state. At threshold, we obtain $E_{0+}=-1.92\times10^{-3}/m_{\pi^+}$. This number is close to the measured value of $E_{0+}=-1.5\times10^{-3}/m_{\pi^+}$. No violation of the low-energy theorem is required to obtain good agreement between the calculated total cross sections and experimental data from threshold to about 400-MeV incident photon energy.

33582 **Possible evidence for four-particle, four-hole excitations in ^{146}Gd.** Heyde, K. (Institute for Nuclear Physics, Proefluinstraat 86, B-9000 Gent, (Belgium)); Meyer, R.A. *Physical Review, C (Nuclear Physics) (USA)*, 41(1): 280-283 (Jan 1990). DOE Contract W-7405-ENG-48.

Excitation in the reaction ^{148}Gd(p,t)^{146}Gd to a 0$^+$ level at 4.534 MeV can be identified with a proton two-particle, two-hole (2p-2h), neutron 2p-2h configuration where the proton 2p-2h configurations act across the Z=64 gap (particle moving in the $1h_{11/2}$ orbital) and the neutron 2p-2h configuration acts across the N=82 closed shell. Here holes are moving mainly in the $1h_{11/2}$ orbital, and the particles move in the high-j $2f_{7/2}$, $1h_{9/2}$, and $1i_{13/2}$ orbitals. A calculation for the position of this 0$^+$ 4p-4h configuration was performed starting from the proton and neutron pairing excitations and using a four-level model with residual proton-neutron interactions. This model predicts an energy of 4.76 MeV for the 4p-4h 0$^+$ state, and the resultant model wave functions can qualitatively explain the transfer reaction cross sections. Existence of a 4p-4h band structure is discussed.

33583 **Ground state of ^{16}O.** Pieper, S.C. (Physics Division, Argonne National Laboratory, Argonne, Illinois 60439-4843 (US)); Wiringa, R.B.; Pandharipande, V.R. *Physical Review Letters (USA)*, 64(4): 364-367 (22 Jan 1990). DOE Contract W-31109-ENG-38.

A variational method is used to study the ground state of ^{16}O. Expectation values are computed with a cluster expansion for the noncentral correlations in the wave function; the central correlations and exchanges are treated to all orders by Monte Carlo integration. The expansion has good convergence. Results are reported for the Argonne v_{14} two-nucleon and Urbana VII three-nucleon potentials.

33584 **Comments on "Neutron-proton mass difference in the chiral solitonic bag model".** Park, B. (Departament de Fisica Teorica, Universitat de Valencia Institut de Fisica Corpuscular, Centro Mixto Universitat de Valencia, Consejo Superior de Investigaciones Cientificas, E-46100 Burjassot, Valencia, Spain (ES)); Rho, M. *Physical Review, D (Particles Fields) (USA)*, 41(1): 310-314 (1 Jan 1990). DOE Contract FG02-88ER40388.

It is pointed out that the topological soliton bag is incompletely quantized in the papers of Durgut, Pak, and Yilmaz and of Wittman and Woloshyn, leading to results on the neutron-proton mass difference and other phenomena that are not implied by the model. The purpose of this paper is to clarify how and where their scheme goes wrong and to propose an alternative consistent scheme of quantization.

33585 **Generalized valley approximation applied to a schematic model of the monopole excitation.** Walet, N.R. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19104 (US)); Klein, A.; Do Dang, G.; Bulgac, A. *Physical Review, C (Nuclear Physics) (USA)*, 41(1): 318-328 (Jan 1990). 40132-5-25351.

In recent years we have developed a new mathematical treatment of large amplitude collective motion in the adiabatic limit and formulated a successful approximation method, called the generalized valley approximation. In this paper we discuss its application to adiabatic time-dependent Hartree theory, for which the method is ideally suited. We apply the method first to an exactly solvable limiting case (the Suzuki model), for which we have shown in a previous paper that the usual form of adiabatic time-dependent Hartree theory is not general enough to yield the exact solution. We introduce an extended theory that remedies this deficiency. The modified theory has also been applied to monopole models close to the Suzuki model that are not exactly solvable. The algorithm developed for this case is sufficiently general to serve as a prototype for those necessary to study more complex realistic models of collective motion.

33586 **Approximate energy correction for particle number symmetry breaking in constrained Hartree-Fock plus BCS calculations.** Quentin, P. (Laboratoire de Physique Theorique, Universite de Bordeaux-1, Chemin du Solarium, 33170 Gradignan, France (FR)); Redon, N.; Meyer, J. *Physical Review, C (Nuclear Physics) (USA)*, 41(1): 341-349 (Jan 1990).

An approximate restoration of the particle number symmetry, in the manner of Lipkin-Nogami, is numerically investigated in the context of constrained Hartree-Fock plus BCS calculations. Its effect is assessed in a variety of physical situations like potential energy landscapes in transitional nuclei, shape isomerism at low spin, and fission barriers of actinide nuclei.

33587 ***Ad hoc* Coulomb corrections to the radiation tail.** Talwar, I. (Computer Science Department, State University of New York at Geneseo, Geneseo, New York 14454 (US)); Wright, L.E.; Hoque, A. *Physical Review, C (Nuclear Physics) (USA)*, 41(1): 382-385 (Jan 1990). DOE Contract FG02-87ER40370.

We give an empirically derived correction factor to an *ad hoc* procedure of including Coulomb corrections in the plane-wave calculation of the radiation tail accompanying elastic electron scattering from the atomic nucleus. Apart from regions of the radiation tail with very large Coulomb distortion effects, our corrected *ad hoc* results agree with a distorted-wave Born approximation calculation of the radiation tail to better than 5%.

33588 **Reply to "Absence of parity effects in preequilibrium γ emission".** Reffo, G. (Comitato Nazionale per la Ricerca e per lo Sviluppo dell'Energia Nucleare e delle Energie Alternative, Bologna, Italy (IT)); Blann, M.; Remington, B.A. *Physical Review, C (Nuclear Physics) (USA)*, 41(1): 403 (Jan 1990). DOE Contract W-7405-ENG-48.

We reply to the preceding Comment.

33589 **Full-folding optical potentials in elastic proton-nucleus scattering.** Elster, C. (Department of Physics, The Ohio State University, Columbus, Ohio 43210 (USA)); Cheon, T.; Redish, E.F.; Tandy, P.C. *Physical Review, C (Nuclear Physics) (USA)*, 41(3): 814-827 (Mar 1990). DOE Contract FG05-87ER40322.

The optical potential for elastic scattering of protons from ^{16}O at incident beam energies between 100 and 500 MeV is calculated from a full-folding integral of a simple s-p-shell representation of the target density matrix together with fully off-shell nucleon-nucleon t matrices derived from two different Bonn meson exchange models. Elastic scattering observables calculated from this full-folding optical potential are compared to those obtained from "optimum factorized" as well as on-shell local ("$t\rho$") approximations. The optimum factorization is found to provide a good approximation to elastic scattering observables obtained from the full-folding optical potential, although the potentials differ in the structure of their nonlocality. A perturbative treatment of the nonlocality is used to extract approximate localized potentials and associated Perey damping factors for the interior wave functions. The results indicate that the interior wave function from the optimum factorization potential and the full-folding potential are very similar.

33590 **Low-energy reactions with heavy deformed nuclei.** Dasso, C.H. (Niels Bohr Institute, University of Copenhagen, Blegdamsvej 17, DK-2100, Copenhagen, Denmark (DK)); Fernandez-Niello, J.; Landowne, S. *Physical Review, C (Nuclear Physics) (USA)*, 41(3): 1014-1017 (Mar 1990). DOE Contract W-31109-ENG-38.

Calculations for ^{154}Sm+^{154}Sm collisions that account for the deformed surfaces indicate that the threshold for nuclear reactions is about 50 MeV below the nominal Coulomb barrier. Some specific features of such low-energy collisions are discussed.

33591 **Mass systematics for A=29–44 nuclei: The deformed A~32 region.** Warburton, E.K. (Brookhaven National Laboratory, Upton, New York 11973 (USA)— Universitaet Heidelberg, Heidelberg, Germany (DE)— Max-Planck-Institut fuer Kernphysik, Heidelberg, West Germany (DE)); Becker, J.A.; Brown, B.A. *Physical Review, C (Nuclear Physics) (USA)*, 41(3): 1147-1166 (Mar 1990). DOE Contract AC02-76CH00016.

Further evidence for the presence of an anomaly in binding energies for the "island of inversion" centered at Z=11, N=21 is obtained by comparison of shell-model calculations to experiment. The calculations were done with a shell-model interaction that is applicable to nuclei with active valence nucleons in both the (1*s*,0*d*) and (0*f*,1*p*) major shells. This interaction is described in detail as are its predictions for binding energies and energy spectra of Z=8–20, N=18–25 nuclei. These calculations provide the background for the exploration of the "island of inversion." The extent of the "island" and the magnitude of the anomaly is explored by calculating the binding energies of $2\hbar\omega$ excitations of neutrons from the (1*s*,0*d*) shell to the (0*f*,1*p*) shell relative to the $0\hbar\omega$ ground state. The reason why mixed $(0+2)\hbar\omega$ calculations are not considered reliable is addressed. Truncation schemes and a weak-coupling approximation are used to extend the range of the calculations. It is found that for Z=10–12, N=20–22 (and possibly N>22) nuclei the lowest $2\hbar\omega$ state is more bound than the $0\hbar\omega$ ground state. The role of odd n $n\hbar\omega$ excitations is considered and it is found that the $1\hbar\omega$ ground state always lies below that of $3\hbar\omega$, and for N=19, 21, and 23, the lowest $1\hbar\omega$ state is in close competition with $2\hbar\omega$ for the lowest binding energy. Collectivity is considered via $E2$ observables and energy spectra for the $2\hbar\omega$ ground-state bands. The reason for the existence of the "island" is discussed.

33592 Quasifree fragmentation of radioactive projectiles: Extended Serber model. Utsunomiya, H. (Cyclotron Institute, Texas A&M University, College Station, Texas 77843 (USA)). *Physical Review, C (Nuclear Physics) (USA),* 41(3): 1309-1310 (Mar 1990).

Transverse momentum distributions recently measured in the radioactive projectile fragmentation at 790 MeV/nucleon are compared to the extended Serber model calculations. It is shown that the observed widths are roughly consistent with the quasifree stripping of a few loosely bound neutrons from the neutron-rich nuclei.

33593 Lattice calculation of muon-pair production with capture in relativistic heavy-ion collisions. Strayer, M.R. (Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831 (USA)); Bottcher, C.; Oberacker, V.E.; Umar, A.S. *Physical Review, A (General Physics) (USA),* 41(3): 1399-1407 (1 Feb 1990).

We present a schematic study of muon-pair production with capture of the negative muon into the $1s_{1/2}$ ground state in relativistic heavy-ion collisions. The muon pairs are generated by a time-dependent, screened electromagnetic field. Our numerical calculations are carried out on a three-dimensional lattice with 20–30 mesh points in each direction, utilizing the B-spline collocation method. Numerical convergence has been demonstrated using a Lorentz-boosted screened Coulomb potential. For the system $^{197}Au+^{197}Au$ at collider energies of 0.2, 1.0, and 2.0, GeV/nucleon, we obtain probabilities for dimuon production with capture between 1.0×10^{-3} and 7.0×10^{-2} at grazing impact parameters. This may indicate that the electromagnetic lepton-pair production is strongly nonperturbative.

33594 Crossing-consistent analysis of kaon photoproduction and radiative capture. Williams, R. (Department of Physics, North Carolina State University, Raleigh, North Carolina 27695-8202 (USA)); Ji, C.; Cotanch, S.R. *Physical Review, D (Particles Fields) (USA),* 41(5): 1449-1455 (1 Mar 1990). DOE Contract FG05-88ER40461.

A crossing-consistent description is presented for K^+ photoproduction $p(\gamma,K^+)\Lambda$ and K^- radiative capture $p(K^-,\gamma)\Lambda$ using an effective-chiral-Lagrangian model. Crossing requires that these reactions should both be described by the same physical model including identical dynamic parameters such as coupling constants. It is demonstrated that previous analyses of these crossing-related reactions, which have also used this effective-chiral-Lagrangian model, have not utilized the crossing constraint and thus do not simultaneously describe both kaon photoproduction and capture. New sets of coupling constants that consistently describe both reactions are presented.

33595 Quadrupole moments and band-mixing in tungsten nuclei. Veskovic, M. (Physics Department, Vanderbilt University, Nashville, Tennessee 37265 (US)); Hamilton, W.D.; Kumar, K. *Physical Review, C (Nuclear Physics) (USA),* 41(1): R1-R4 (Jan 1990). DOE Contract FG05-88ER40407;AC05-76OR00033;FG05-87ER40361.

The dynamic deformation model has been used to examine collective features of tungsten isotopes. The magnitudes and signs of calculated Q values as well as the ratios $Q(2_\gamma^+)/Q(2_g^+)$ agree well with recent experimental results. The amount of K=0 component in the 2_γ^+ state is found to be about 10%, but the K=2 component in 2_g^+ state ranges from 9 to 47 % for the tungsten isotopes A=180–186. A significant K=0, K=2, and K=4 mixing occurs for I>4 states. Results are supported by published data and also by the $X(E0/E2)$ value for the 792 keV transition between 2_γ^+ and 2_g^+ states in ^{18}W.

6540 Radiation and Shielding Physics

Refer also to citation(s) 32830, 32831, 32882, 32986, 32988

33596 (NUREG/CR–5468) **QADS: A multidimensional point kernel analysis module.** Broadhead, B.L. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Safeguards and Transportation; Oak Ridge National Lab., TN (USA). May 1990. 57p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. (ORNL/CSD/TM–270). Available from NTIS, PC A04/MF A01 - GPO; OSTI; INIS.

QADS is a multidimensional point kernel computer code that utilizes the simplified free-form input of the SCALE system as well as compatibility with ORIGEN-S produced sources, SCALE cross section libraries, and standard composition data sets. QADS consists of a preprocessor that takes the free-form input and prepares input for the widely available QAD-CGGP code, which is then automatically executed by a driver module. This report describes the point kernel theory briefly, followed by numerous tips on successfully applying the theory to various types of shielding problems. The remainder of the document is devoted to input and output descriptions of the QADS code with several illustrative sample problems. 4 refs., 5 figs., 7 tabs.

33597 Transport of fast electrons through thin foils. Lencinas, S. (Institut fuer Kernphysik der J. W. Goethe Universitaet, 6000 Frankfurt/M 90, (West Germany)); Burgdoerfer, J.; Kemmler, J.; Heil, O.; Kroneberger, K.; Keller, N.; Rothard, H. *Physical Review, A (General Physics) (USA),* 41(3): 1435-1443 (1 Feb 1990). DOE Contract AC05-84OR21400.

We investigate both experimentally and theoretically the energy and angular distribution of fast monoenergetic electrons penetrating very thin foils with a thickness of the order of a few λ_f, the mean free path for free-electron scattering. The measured distribution functions display three distinctive components of zero scattering, single scattering, and multiple scattering, in both angle and energy. The description in terms of a kinetic equation (or equivalently, phase-space master equation) is discussed. Its numerical application is facilitated by a multiple-scattering expansion. Good agreement between experiment and theory is found.

33598 Recommended Bethe–Bloch stopping power parameters for Kapton and Havar. Porter, L.E. (University of Montana, Missoula, Montana 59812 (US)). *Journal of Applied Physics (USA),* 67(4): 1639-1642 (15 Feb 1990).

Previous measurements of the stopping power of Kapton and Havar for 1.1–4.4-MeV protons have been analyzed with modified Bethe–Bloch theory in order to extract some of the parameters required in the formalism. Results suggest the possibility of systematic errors, in that the Havar data appear to have been slightly high and the Kapton data quite low when compared with other reported measurements. Currently recommended values of the mean excitation energy and Barkas-effect parameter are, respectively, 79 eV and 1.34 (Kapton) and 296 eV and 1.36 (Havar). The need for further accurate measurements for Kapton in particular is emphasized.

6550 Medical Physics

Refer also to citation(s) 33130

33599 (CNIC–00223) **Survey and assessment of radioactivity level in Yangtze River water system.** Li Zhenping (Ministry of Nuclear Industry, Beijing, BJ (China). Bureau of Safty, Protection and Health); Wang Zhibo; Sun Weifan; Chen Mingjun; Zhu Zhennan; Wang Zhiming; Li Shengfang. China Nuclear Information Centre, Beijing, BJ (China). Aug 1988. 20p. (In Chinese). (BSPHN–0001). Order Number DE90628023. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Large number of samples taken from main stream of Yangtze River and its tributary were analysed and investigated in the dry season and rich water season in 1984. the number of sampling sites were 119. The sampling mediums included water, clay, fishes and soil. The items of analysis included total α, total β, ^{3}H, ^{40}K, ^{90}Sr, ^{137}Cs, U,Th, ^{226}Ra, ^{210}Po and ^{239}Pu. New informations about the present situation, distribution characteristics and trends in the change of radioactivity levels in Yangtze River water system were obtained through the investigation. The results showed that the raioactivity levels of each nuclide in Yangtze River water system were still lower than that of background, and did not cause contamination. The estimation of radiation dosage showed that the maximum effective dose equivalent received by local residents from water in Yangtze River area was only about 2% of natural radiation level in the area.

33600 (IPEN-PUB–283) **Evaluation of the effective equivalent dose in the general public due to the discharge of uranium in groundwater.** Gordon, A.M.P.L.; Jacomino, V.M.F. Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, SP (Brazil). Dec 1989. 29p. (In Portuguese). Order Number DE90626625. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Some facilities available at IPEN-CNEN/SP may discharge uranium in their liquid effluents. The uranium contents of these effluents are analyzed by photometry or fluorimetry, and according to the results obtained a decision is made, by the Environmental Monitoring Division, upon their discharge to the environment. In 1988 a total activity of 3.66×10^{9} Bq of uranium was discharge in a volume of approximately 30 m^3. The effective equivalent dose in the general public was evaluated by making a conservative assumption that all the liquid effluents containing uranium are discharged directly to the soil reaching the groundwater. The dose calculation was carried out by using a generic model which described the transport of radionuclides in the groundwater. In order to be conservative it was also assumed that the critical pathway is the direct in gestion of water through hypothetical wells around the Institute. Conservative assumptions were also made in the characterization of the local aquifer parameters such as vertical and longitudinal dispersivity, effective porosity of the soil, hydraulic conductivity etc., in roder to overestimate the effective equivalent dose. The result obtained, of 5.3×10^{-10} mSv/a is far below the dose limit for the public adopted by the Radiological Protection Board. The derived limit for the discharge was also evaluated, using the same model, giving a result of 3.6×10^{13}Bq/a. (author).

33601 (NIRS-M–73, pp. 218-223) **An estimation of contribution to the population dose in Japan.** Abe, Shiro (National Inst. of Radiological Sciences, Chiba (Japan)). National Inst. of Radiological Sciences, Chiba (Japan). Mar 1989. (In Japanese). (CONF-8712153–: 15. NIRS seminar on environmental research, Chiba (Japan), 3-4 Dec 1987). In *Radon in the living environment: Levels and risks.* Order Number DE90705994. Available from NTIS (US Sales Only), PC A15/MF A01.

The ultimate purpose of this study was to derive the population dose of Japan. Radon daughter, not radon itself, should be considered as a major influential component for the human body in estimating the average individual dose (per caput dose) due to radon family. The measurement of radon daughters at many points is, however, difficult from both technical and financial points of view. Most practically, it is then recommended that a large survey for the radon gas concentration and a measurement of the radon daughter concentration be conducted at the limited number of points. In this respect, a nation-wide survey of the radon gas concentration has been carried out by using 500 passive radon monitors with electrostatic field over more than 1.5 years. Long-term continuous measurements of individual radon daughter (Ra-A, B, C) concentrations and their free component concentrations have also been performed. In calculating the effective dose equivalent, characteristics of Japan and Japanese should be taken into account as parameters. A survey revealed the radon gas concentration to be approximately 10 Bq/m^3 indoors and approximately 5 Bq/m^3 outdoors. The equilibrium factor was estimated to be approximately 0.6 for outdoor conditions and approximately 0.5 for indoor conditions. The fraction of free components was estimated to be below 0.05. On the basis of the above equilibrium equivalent factors and fractions of free components, as well as the particle size distribution, the dose conversion factor was similar to values reported by the United Nations Scientific Committee on the Effects of Atomic Radiation (1982)– that is, 8.7 nSv/(Bqh/m^3) for indoor conditions and 17 nSv/(Bqh/m^3) for outdoor conditions. The occupancy factor was considered to be 0.2 for outdoor and 0.8 for indoor conditions. Combining these parameters is necessary for calculating the national dose caused by radon family. (N.K.).

33602 (NIRS-R–18) **Report of radioactivity survey research in fiscal year 1988.** National Inst. of Radiological Sciences, Chiba (Japan). Dec 1989. 115p. (In Japanese). Order Number DE90791336. Available from NTIS (US Sales Only), PC A06/MF A01.

The National Institute of Radiological Sciences has been surveyed, as part of the radioactivity research project by the Science and Technology Agency, radioactivity levels in the environment and safety analysis for radioactive fallouts associated with nuclear weapons tests since 1959 and effluents from nuclear installations. With a remarkable advent of the peaceful applications of radionuclides, radioactivity in the environment has been becoming a matter of concern for the population in Japan. Radioactivity research is considered to become more important because it may provide clues for the basis of its influences upon the human body and environment. This report gives a survey of the radioactivity research project performed in the fiscal year 1988. The following topics are covered: (1) radioactivity levels and dosimetry in the environment, foods, and human body; (2) radioactivity levels surrounding nuclear installations; (3) services in the Radioactivity Survey Data Center; (4) basic survey of evaluation for the results of radioactivity levels; (5) training of technichians for monitoring environmental radioactivity; and (6) survey research for dosimetry and countermeasures at emergency. (N.K.).

33603 (PNC-TN–8410-89-047) **Factors affecting passive monitoring of radon.** Asano, Tomohiro (Power Reactor and Nuclear Fuel Development Corp., Tokai, Ibaraki (Japan). Tokai Works); Kahn, B. Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan). Sep 1989. 81p. Order Number DE90791115. Available from NTIS (US Sales Only), PC A05/MF A01.

In recent years, increasing cancer has been expressed as a possible health hazards associated with long-term exposures to a large population at a low level of radon in the environment. Because radon is ubiquitous nuclide, nation-wide monitoring is necessary to determine lung cancer risk. For such purpose, passive sampling methods with track etch detector or charcoal adsorption collector may have the advantage in lower cost and convenience. The charcoal adsorption collector is considered in this study. Various factors may significantly affect the charcoal adsorption mechanism on its practical application. Moisture effects are discussed here as having major impact on radon collection by charcoal. Set of equations are presented in this report to describe adsorption of radon including moisture effects. (author) 61 refs.

33604 (RERF-TR–11-89) **Calibration of Mg_2SiO_4(Tb) thermoluminescent dosimeters for use in determining diagnostic X-ray doses to Adult Health Study participants.** Kato, Kazuo; Antoku, Shigetoshi; Sawada, Shozo; Russell, W.J. Radiation Effects Research Foundation, Hiroshima (Japan). Nov 1989. 13p. Order Number DE90791088. Available from NTIS (US Sales Only), PC A03/MF A01.

Characteristics of Mg_2SiO_4(Tb) thermoluminescent dosimeters (TLD) were ascertained preparatory to measuring dose from diagnostic X-ray examinations received by Adult Health Study participants. These detectors are small, relatively sensitive to low-dose X rays, and are appropriate for precise dosimetry. Extensive calibration is necessary for precisely determining doses according to

their thermoluminescent intensities. Their sensitivities were investigated, by dose according to X-ray tube voltage, and by exposure direction, to obtain directional dependence. Dosimeter sensitivity lessened due to the fading effect and diminution of the planchet. However, these adverse effects can be avoided by storing the dosimeters at least 1.5 hours and by using fresh silver-plated planchets. Thus, the TLDs, for which sensitivities were determined in this study, will be useful in subsequent diagnostic X-ray dosimetry. (author).

33605 (SAAS-Mitt–89-11) **Standard operational radiation protection instructions for process instrumentation and control engineering applying radiometric equipment containing sealed sources.** Staatliches Amt fuer Atomsicherheit und Strahlenschutz, Berlin (German Democratic Republic). 1989. 19p. (In German). Order Number DE90628021. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

According to article 16(3) of the Ordinance on the Implementation of Atomic Safety and Radiation Protection of 11 October 1984, operational radiation protection instructions have to be worked out for each type of nuclear energy application. Based on the valid legal provisions of the GDR and on experience and knowledge gained in practice, the most important operational instructions and procedures for the operation of radiometric equipment containing sealed sources were compiled. The example should enable the management to make the instructions directly applicable and, if necessary, to modify or supplement them.

33606 (SSI–89-12) **Nuclear power industry: - activity discharge, - occupational exposures. Fourth quarter of 1988.** National Inst. of Radiation Protection, Stockholm (Sweden). 10 Aug 1989. 46p. (In Swedish). Order Number DE90628030. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A complication of radioactivity discharges and personnel dose at Swedish nuclear facilities oct-dec 1988, plus cumulated valves for 1988.

6560 Condensed Matter Physics

Refer also to citation(s) 32568, 32569, 32573, 32575, 32580, 32604, 32627, 32635, 32637, 32645, 32648, 32649, 32663, 32664, 32713, 32716, 32718, 32725, 32726, 32730, 32734, 32770, 32884, 32977, 33342, 33344, 33496

33607 (ANL-Trans–89-52) **Circumfluous motion of a conductive liquid around solid objects in a magnetic field.** Tsinober, A.B. (AN Latvijskoj SSR, Riga (USSR). Inst. Fiziki); Shtern, A.G.; Shcherbinin, E.V. Argonne National Lab., IL (USA). 1 Dec 1989. 14p. Translated from Izvestiya Akademii Nauk Latviiskoi SSR, Seriya Fizicheskikh i Technicheskikh Nauk (Latvian S.S.R.); No. 4, 31-40(1964). Sponsored by U.S. DOE Energy Research. DOE Contract W-31-109-ENG-38. Order Number DE90011335. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Experiments aimed at an investigation of the influence exerted by a magnetic field on the resistance associated with the circumfluous motion of mercury around conductive solids are described in the first part of this work. It is learned that when good electrical contract is present between the mercury and the solid that it flows around, the resistance of the solid increases with an increase in its electric conduction. The second part of this text is devoted to a study of the influence exerted by a magnetic field on the distribution of pressure along a circular cylinder. It is shown that when a magnetic field is applied, pressure along the front portion of the cylinder increases, so that the pressure coefficient in place at the leading stagnation point becomes greater than unity. Pressure along the afterbody of the cylinder decreases. The resistance increase resulting from pressure variation accounts for 40–50% of the increase in total resistance. 9 refs., 5 figs.

33608 (CBPF-NF–038/89) **Systematic approach to critical phenomena by the extended variational method and coherent-anomaly method.** Kawashima, N. (Tokyo Univ. (Japan). Dept. of Physics); Katori, M.; Tsallis, C.; Suzuki, M. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 24p. Order Number DE90627320. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A general procedure to study critical phenomena of magnetic systems is discussed. It consists of systematic series of Landau-like approximations (Extended Variational Method) and the coherent-anomaly method (CAM). As for susceptibility, the present method is equivalent to the power-series CAM theory. On the other hand, the EVM gives a set of new approximants for other physical quantities. Applications to d-dimensional Ising ferromagnets are also described. The critical points and exponents are estimated with high accuracy. (author).

33609 (CBPF-NF–039/89) **Criticality of the three-state chiral clock model: a renormalisation group study.** Martins, M.L.; Tsallis, C. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 18p. Order Number DE90627321. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Within a real space renormalisation group approach, the phase diagram and the universality classes of the three-state chiral clock model in a self-dual planar hierarchical lattice are studied. It is found that, the chiral field Δ is relevant at the pure Potts critical point with a crossover exponent $\phi \simeq 0.32$. The critical line which separarates the ferromagnetic phase from the non-ferromagnetic ones is characterized by a multicritical (Lifshitz) point located at $(K,\Delta) \simeq (1.452,0.382)$. The ferromagnetic phase appears to be divided into two regions by a wetting line which is also located numerically. The various critical lines and point of the phase diagram are believed to be excellent approximations for the square lattice. (author).

33610 (CBPF-NF–040/89) **A generalised Hubbard Hamiltonian: influence of temperature and fractality.** Cannas, S.A.; Tamarit, F.A.; Tsallis, C. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 18p. Order Number DE90627322. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A generalised Hubbard Hamiltonian which is invariant under a Real Space Renormalisation Group is considered. Within the present approximation, the Bravais lattice is replaced by a diamond-like hierarchical lattice. The phase diagram associated with the half-filled band Hubbard Hamiltonian in d = 1, 2 and 3, in the full range of the dimensionless intra-atomic interaction U and hopping t parameters is calculated. The influene of the hierarchical lattice fractality is analised as well. (author).

33611 (CBPF-NF–041/89) **Z(6) model: criticality and break-collapse method.** Mariz, A.M. (Rio Grande do Norte Univ., Natal (Brazil). Dept. de Fisica); Silva, L.R. da; Magalhaes, A.C.N. de; Tsallis, C. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 39p. Order Number DE90627323. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The phase diagram and thermal and crossover exponents of the z (6) ferromagnet on the square lattice are calculated within a real-space renormalization group (RG) scheme. The obtained phase diagram (exhibiting 4 phases corresponding to Z (6), Z (3), Z (2) and completely broken symmetries) contains all exactly known critical points, and possibly is an excellent approximation every-where except in the high-temperature region where a soft phase is expected to appear. However, all the obtained results are exact in the Wheatstone-bridge hierarchical lattice. In addition to these resuls, an operational procedure (the "break-collapse method") which considerably simplifies the exact calculation of two-spin correlation functions for arbitrary Z (6) two-rooted clusters (frequent in RG approaches) is presented. (author).

33612 (CBPF-NF–045/89) **Radiation-induced paramagnetic species in natural calcite speleothems.** Rossi, A.M.; Poupeau, G. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 26p. Order Number DE90627338. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The ESR natural spectrum of humic-free speleothem calcite single crytals in the region of g = 2.0000 is a composite of lines from 4 radiogenic species, in addition to Mn^{++} lines. Laboratory irradiation causes appearrance of three more species. Use of isotropic F species (g = 2.0003) for dating is possible if specific cautions are followed. (author).

33613 (CBPF-NF–051/89) **Susceptibility of the Potts model in an hierarchical lattice: renormalisation group approach.** Silva, E. de P. da; Tsallis, C. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 29p. Order Number DE90627324. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Using a real space renormalization group method, the thermal dependence of the susceptibility of the q-state Potts model (ferro-and antiferromagnet) on self-dual Wheatstone-bridge-like hierarchical lattices is calculated. The influence of external fields on the antiferromagnetic phase diagram is discussed as well. (author).

33614 (CEA-CONF–9903) **Glancing incidence neutron scattering.** Jannink, G.; Farnoux, B.; Des Cloiseaux, J. Laboratoire Leon Brillouin, Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). 1989. 8p. (CONF-8905161–: International conference on surface and thin film studies using glancing-incidence x-ray and neutron scattering, Marseille (France), 31 May - 2 jun 1989). Order Number DE90793001. Available from NTIS (US Sales Only), PC A02/MF A01.

We discuss an approach to the neutron glancing incidence experiment by polymer interfaces: Singular properties at total reflection edge are confronted to experimental possibilities.

33615 (CONF-900466–38) **Calculation of free energy from the internal-energy distribution function.** Phillpot, S.R.; Rickman, J.M. Argonne National Lab., IL (USA). May 1990. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90011111. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We outline a new method for the calculation of free energies from a cumulant analysis of the internal-energy distribution function obtained from a Monte-Carlo simulation. The new methodology is validated by comparing the free energy calculated for a perfect crystal from this approach with the free energy calculated by a temperature integration scheme. By comparing the two methods for an inhomogeneous system containing grain boundaries, we investigate the effects of the local-strain distribution on the free energy; for the superlattice of twist grain boundaries studied here, the effects are fond to be small. 11 refs., 3 figs.

33616 (CONF-900582–1) **Convoy electrons.** Burgdoerfer, J. (Tennessee Univ., Knoxville, TN (USA). Dept. of Physics and Astronomy). Oak Ridge National Lab., TN (USA). [1990]. 45p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract AC05-84OR21400. From NATO Advanced Study Institute on interaction of charged particles with solids and surfaces; Alicante (Spain); 6-18 May 1990. Order Number DE90011381. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Recent developments in the theory of the production and of the transport of convoy electrons through solids are reviewed. Similarities and differences to cusp electron emission in binary ion-atom collisions and to transport of "free" electrons through solids are highlighted. We also discuss recent observations of convoy electron emission in ion-surface collisions at small glancing angles. 36 refs., 13 figs.

33617 (DOE/ER/13933–T1) **Quantum state resolved desorption of CO from solid surfaces: Progress report, June 15, 1989–June 14, 1990.** Janda, K.C. Pittsburgh Univ., PA (USA). Dept. of Chemistry. May 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER13933. Order Number DE90011120. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This report discusses the following: Hydrogen recombination of Si(100) surfaces; Isotope mixing between Co molecules on K promoted Ni(111); and multiphoton ionization. (LSP)

33618 (DOE/ER/45373–2) **Single-electron charging effects: Technical progress report.** Ruggiero, S.T. Notre Dame Univ., IN (USA). [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER45373. Order Number DE90011421. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The status of our project on single-electron tunneling is at this point excellent. As outlined in our original proposal, a key goal in the development of this project was the demonstration and exploration of the microwave properties of single-electron systems. As discussed here, such work has to date been carried out.

33619 (IC–89/317) **Surface photovoltage spectroscopy of real n-type GaAs(110) surfaces.** El-Dessouki, M.S. (International Centre for Theoretical Physics, Trieste (Italy)); El-Guiziri, S.B.; Gobrial, F.Z. International Centre for Theoretical Physics, Trieste (Italy). Oct 1989. 19p. Order Number DE90627325. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

N-type GaAs single crystals cut parallel to the (110) plane and doped with phosphorus by ion beam implantation were used in the present study. Temperature dependence of the bulk electrical conductivity showed two distinct activated regions with activation energies $Et_1=0.75\pm0.04$eV, and $Et_2=0.12\pm0.04$eV. The first activation energy is probably that of deep phosphorous impurities, while the second was related to long range disorder in the sample near room temperature. Surface photovoltage studies at room temperature were carried out at atmospheric pressure and in vacuum for etched and unetched samples. For n-type GaAs etched surface, the experimentally observed surface states were not found to change their positions by changing the pressure. But in the case of etched samples the surface states showed some redistribution under vacuum. The time constants for the initial rise and fall of CPD by illumination and after switching it off, τ_1 and τ_2, respectively, were found to depend on the illumination intensity and photon energy. Their values range between 4 and 15 s. (author). 31 refs, 6 figs, 1 tab.

33620 (IC–89/389) **How to interpret the validity of the single band model?.** Pang, H.B. (International Centre for Theoretical Physics, Trieste (Italy)); Su, Z.B.; Yu, L.; Xiang, T. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 15p. Order Number DE90627313. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

There is an ongoing debate whether the generalized two-band Hubbard model is equivalent to the single band t-J model. Starting from a two-band model, by constructing the singlet and triplet bands and considering their hybridization, we are able to reproduce very well the exact solution in a ferromagnetic background. Hence the singlet band model is a good approximation for low energy states, although the spin expectation is not exactly zero. The oxygen-oxygen direct hopping is also considered to argue that the single-band model might be still valid even in this case. (author). 15 refs, 2 figs.

33621 (IC–89/391) **Self-consistent hole motion and spin excitations in a quantum antiferromagnet.** Su, Z.B. (International Centre for Theoretical Physics, Trieste (Italy)); Yu, L.; Li, Y.M.; Lai, W.Y. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 20p. Order Number DE90627314. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A new quantum Bogoliubov-de Gennes (BdeG) formalism is developed to study the self-consistent motion of holes and spin excitations in a quantum antiferromagnet within the generalized t-J model. On the one hand, the effects of local distortion of spin configurations and the renormalization of the hole motion due to virtual excitations of the distorted spin background are treated on an equal footing to obtain the hole wave function and its spectrum, as well as the effective mass for a propagating hole. On the other hand, the change of the spin excitation spectrum and the spin correlations due to the presence of dynamical holes are studied within the same adiabatic approximation. The stability of the hole states with respect to such changes justifies the self-consistency of the proposed formalism. (author). 25 refs, 6 figs, 1 tab.

33622 (IC–89/400) **New real space correlated-basis-functions approach for the electron correlations of the semiconductor inversion layer.** Feng Weiguo (International Centre for Theoretical Physics, Trieste (Italy)); Wang Hongwei; Wu Xiang. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 9p. Order Number DE90627315. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Based on the real space Correlated-Basis-Functions theory and the collective oscillation behaviour of the electron gas with effective Coulomb interaction, the many body wave function is obtained for the quasi-two-dimensional electron system in the semiconductor inversion layer. The pair-correlation function and the correlation energy of the system have been calculated by the integro-differential method in this paper. The comparison with the other previous theoretical results is also made. The new theoretical approach and its numerical results show that the pair-correlation functions are definitely positive and satisfy the normalization condition. (author). 10 refs, 2 figs.

33623 (IC–89/401) **Effect of retardation on the reflectance properties of the metallic Fibonacci quasi-superlattice.** Feng Weiguo (International Centre for Theoretical Physics, Trieste (Italy)); Yao Hesheng; Xu Xiang. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 14p. Order Number DE90627316. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Based on the hydrodynamic model theory and the transfer matrix method, we have re-examined the reflection properties by taking account of the retardation effect to the system of the metallic Fibonacci quasi-superlattice. For the normal incident S-polarized Soft X-rays and extreme ultraviolet, we find that the self-similar reflecting spectrum will be restrained with the increasing of the retardation, but for the higher frequency region or at the smaller grazing angle, the self similarity will still exist for the lower generation quasi-superlattice. (author). 19 refs, 2 figs, 1 tab.

33624 (IC–89/407) **Quantum Ising model on hierarchical structures.** Lin Zhifang; Tao Ruibao. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 11p. Order Number DE90627317. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A quantum Ising chain with both the exchange couplings and the transverse fields arranged in a hierarchical way is considered. Exact analytical results for the critical line and energy gap are obtained. It is shown that when $R_1 \neq R_2$, where R_1 and R_2 are the hierarchical parameters for the exchange couplings and the transverse fields, respectively, the system undergoes a phase transition in different universality class from the pure quantum Ising chain with $R_1=R_2=1$. On the other hand, when $R_1=R_2=R$, there exists a critical value R_c dependent on the furcating number of the hierarchy. In case of $R>R_c$, the system is shown to exhibit an Ising-like critical point with the critical behaviour the same as in the pure case, while for $R<R_c$ the system belongs to another universality class. (author). 19 refs, 2 figs.

33625 (IC–89/417) **On hydrogen chemisorption on metals: The electron correlation effects.** Taranko, R.; Cardenas, R.; Taranko, E.; Fedyanin, V.K. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 14p. Order Number DE90627318. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Within the composite Anderson-Ising Hamiltonian method the coverage dependence of the adatom charge and the adatom local density of states have been investigated. The electron intra-atomic Coulomb correlations on the adatom were included up to the second order in V (the single particle hopping strength between the adatom and the substrate) using the Bragg-Williams approximation for the ionic adsorbate component. For a model system describing hydrogen chemisorption on cubium were obtained values of the adatom charge smaller than the corresponding ones calculated within the Hartree-Fock approach and the second-order self-matrix formalism of Brenig and Schonhammer. (author). 24 refs, 2 figs.

33626 (IC–90/2) **Correlated basis function method for fermions on a lattice: The 1-dimensional Hubbard model.** Wang, X.Q. (International School of Advanced Studies, Trieste (Italy)); Fantoni, S.; Viviani, M.; Tosatti, E.; Yu, L. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 63p. Order Number DE90627319. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

We introduce a new lattice version of the Correlated Basis Function (CBF) approach for the study of strongly interacting electrons. As a first application we have chosen the 1 dimensional Hubbard model. For this system, we have implemented different types of correlations: namely, (a) Gutzwiller; (b) Jastrow; (c) nearest-neighbour spin-spin; (d) excitonic (e-d); (f) pairing (BCS). The resulting energies, momentum distribution and other quantities are compared with exact results (when available), and are discussed, both from the methodological and physical point of view. The most important correlations that are needed to obtain good ground state energies are found to be Gutzwiller (reduced double occupancy) plus e-d correlations (between empty and doubly occupied sites), in agreement with other studies. (author). 39 refs, 14 figs, 12 tabs.

33627 (IPPCZ–293/II, pp. 24-37) **Complex experiment in plasma jet spraying of coatings.** Lyagushkin, V.P. (AN SSSR, Novosibirsk (USSR). Inst. Teplofiziki); Solonenko, O.P.; Pekshev, P.Yu.; Safyullin, V.A.; Chisty, A.F. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

Reliable information on the processes affecting the structure and properties of plasma-sprayed coatings, on which optimization of the coatings could be based, can be obtained in complex experiments only. Such experiments should combine advanced diagnostics and modelling of plasma jets and gas-disperse flows, and investigation of disperse materials and sprayed coatings. An example of a complex experimental set-up for investigation of plasma jet spraying of corundum coatings is given. The computer controlled experimental bench is described in detail and some experimental results concerning the coating properties are presented. (J.U.). 5 figs., 12 refs.

33628 (IPPCZ–293/II, pp. 38-49) **Application of low-temperature plasma generators for intensification of melting processes in induction furnaces.** Svidunovich, N.A. (Belorusskij Tekhnologicheskij Inst., Minsk (Byelorussian SSR)); Garost, A.I. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (In Russian). (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

Industrial plasmatrons are prospective heat sources for metallurgy. Especially when used for additional metal heating in induction furnaces, they could bring a substantial enhancement of the heating rate and acceleration of the melting processes. To determine the optimum metal heating conditions and to develop the method of calculating the parameters of plasma-induction furnaces, an experimental plasmatron (metallurgical plasma jet) was constructed and tested on a special calorimetric stand. The results are reported of studies of the dependence of heating efficiency on the plasmatron characteristics. (J.U.). 6 figs., 2 tabs., 6 refs.

33629 (IPPCZ–293/II, pp. 55-63) **Enhancement of the deposition rate of PAL 160 plasmatrons by using a multiple supply of spray material.** Neufuss, K. (Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu); Zdrazil, S. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (In Russian). (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

The feasibility of improving the performance parameters of Czechoslovak plasmatron PAL 160, developed for plasma arc spraying of various metallic and nonmetallic powder materials, is discussed. The results of measurements of the energy balance, deposition rate and efficiency are reported. The form and size of the deposited spot depend on the location and number of supplies of the spray powder. With increasing number of powder suplies the deposition rate increases but the deposition efficiency remains practically unchanged. The plasmatrons with enhanced deposition rate were tested in a number of industrial applications. (J.U.). 5 figs., 2 tabs.

33630 (PB–90-180019/XAB) **Francis Bitter National Magnet Laboratory annual report, July 1988 through June 1989.** Massachusetts Inst. of Tech., Cambridge, MA (USA). Francis Bitter National Magnet Lab. 1989. 154p. Available from NTIS, PC A08/MF A01.

See also PB–89-161731.

Contents include: reports on laboratory research programs–magneto-optics and semiconductor physics, magnetism, superconductivity, solid-state nuclear magnetic resonance, condensed-matter chemistry, biomagnetism, magnet technology, instrumentation for high-magnetic-field research, molecular biophysics; reports of visiting scientists–reports of users of the High Magnetic Field Facility, reports of users of the Pulsed Field Facility, reports of users of the SQUID Magnetometer and Moessbauer Facility, reports of users of the High-Field NMR Facility; Appendices–publications and meeting speeches, organization, summary of High-Field Magnet Facility use January 1, 1981 through December 31, 1988; geographic distribution of High-Field Magnet users (excluding laboratory staff); and summary of educational activities.

33631 (PB–90-182213/XAB) **NIST (National Institute of Standards and Technology) research reports, January 1990. Special pub.** National Inst. of Standards and Technology, Gaithersburg, MD (USA). Jan 1990. 36p. (NIST/SP–770). Available from NTIS, PC A03/MF A01.

Also available from Supt. of Docs as SN003-003-02993-9. See also PB–89-235113.

Contents include: research updates; the long road to superconductivity; following the low road (low temperature superconductivity); an answer to the challenge–automation; biotechnology research facility dedicated; switches that turn on genes; the shop of the 90's (automated factories); how to reduce the risk of virus attacks (computer security); performance of steels exposed to fire predicted; model to fight fire deaths, costs; data, anyone; new publications; conference calendar.

33632 (SAND–90-1265C) **Sedimentation of particles through quiescent suspensions.** Abbott, J.R. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Chemical Engineering); Brenner, H.; Graham, A.L.; Mondy, L.A. Sandia National Labs., Albuquerque, NM (USA); Los Alamos National Lab., NM (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789;W-7405-ENG-36. (CONF-9005183–1: 8. symposium on energy engineering sciences, Argonne, IL (USA), 9-11 May 1990). Order Number DE90011018. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Studies of falling-ball rheometry in concentrated suspensions, embodying a combination of analysis experiment, and numerical simulation, are discussed. Experiments involve tracking small balls falling slowly through otherwise quiescent suspensions of neutrally buoyant particles. A theory has been developed relating the average ball velocity to the macroscopic suspension viscosity, and, for dilute suspensions, agreement is obtained with Einstein's sheared suspension viscosity. Detailed trajectories of the balls, obtained either with new experimental techniques or by numerical simulation, are statistically interpreted in terms of the mean settling velocity and the dispersion about that mean. We show that falling-ball rheometry, using small balls relative to the suspended particles, can be a means of measuring the macroscopic zero-shear viscosity without disturbing the original microstructure significantly; therefore, falling-ball rheometry can be a powerful tool to study the effects of microstructure on the macroscopic properties of suspensions. 25 refs.

33633 **Pairing in CuO_2 driven by exchange interactions between carriers and localized Cu spins.** Stechel, E.B. (Solid State Theory Div., 1151, Sandia National Lab, Albuquerque, NM (US)); Jennison, D.R. 765-766 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract AC04-76DP00789. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Calculations using a realistic multi-band extended Hubbard Hamiltonian, which correctly describes the Heisenberg excitation spectrum and superexchange energy of the insulating phase of CuO_2, show that the two largest energies relating to the carrier quasiparticle are the carrier bandwidth (> 5 eV) and an exceptionally large ~3 eV times a density of states factor as in an RKKY interaction effective exchange energy between a delocalized carrier hole and a localized Cu hole. The Cu holes are found to remain localized in the superconducting materials. Calculations using a model pairing Hamiltonian show that this exchange energy induces (through partial spin-polarization of the Cu holes) an attraction between carriers. This attraction is strong enough to overcome a realistic Coulomb repulsion, hence leading to net attractive pairing. Triplet p-wave (or possible singlet d-wave) pairing is implied.

33634 **Thermodynamic parallels between solid-state amorphization and melting.** Wolf, D. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439 (USA)); Okamoto, P.R.; Yip, S.; Lutsko, J.F.; Kluge, M. *Journal of Materials Research (USA)*, 5(2): 286-301 (Feb 1990). DOE Contract W-31109-ENG-38.

A thermodynamics-based description, in the form of an extended phase diagram, of melting and solid-state amorphization is proposed which brings out the parallels between these two phenomena and suggests that their underlying causes are apparently the same. Through molecular dynamics simulations we demonstrate that every crystal, in principle, can undergo two different types of melting transitions with characteristic features that are also observed in radiation- and hydrogenation-induced amorphization experiments on ordered alloys. The first type, defined in terms of free energies, is shown to involve the heterogeneous nucleation of the liquid or amorphous phase at extended lattice defects (such as grain boundaries, free surfaces, voids, or dislocations) and subsequent thermally-activated propagation of solid-liquid/amorphous interfaces through the crystal. The second type, arising from a mechanical instability limit described by Born, is homogeneous and does not require thermally-activated atom mobility. It is suggested that the role of chemical and structural disordering, a prerequisite for irradiation—but not hydrogenation—induced solid-state amorphization, is merely to drive the crystal lattice to a critical combination of volume and temperature at which the amorphous phase can form either heterogeneously or homogeneously.

33635 **High-resolution study of dielectronic capture by channeled Tl ions.** Belkacem, A. (Argonne National Laboratory, Argonne, Illinois 60439 (US)); Kanter, E.P.; Rehm, K.E.; Bernstein, E.M.; Clark, M.W.; Ferguson, S.M.; Tanis, J.A.; Berkner, K.H.; Schneider, D. *Physical Review Letters (USA)*, 64(4): 380-383 (22 Jan 1990). DOE Contract W-31109-ENG-38.

Charge-changing processes have been investigated for 267–320-MeV Tl^{19+} and Tl^{20+} ions channeled in a thin gold crystal. High-resolution measurements of the energy losses suffered by the charge-changed ions show that electron capture by the well-channeled particles is significantly enhanced when the projectile velocity corresponds to ejected *KLL* Auger-electron energies from doubly excited states in the rest frame of the ion. The measurements of dielectronic capture exhibit exceedingly narrow resonance widths and reveal a shift of the resonances toward higher energies.

33636 **Phonon temperature overshoot in GaAs excited by subpicosecond laser pulses.** Kim, D. (Department of Physics, University of California, Berkeley, California 94720 (US)—Materials and Chemical Sciences Division, Lawrence Berkeley Laboratory, 1 Cyclotron Road, Berkeley, California 94720); Yu, P.Y. *Physical Review Letters (USA)*, 64(8): 946-949 (19 Feb 1990). DOE Contract AC03-76SF00098.

Hot electrons and phonons excited in GaAs by subpicosecond laser pulses have been studied by inelastic light scattering for photoexcited electron densities varying between 10^{17} and 10^{19} cm^{-3}. Transient overshoot of longitudinal-optical (LO) phonon temperature above the electron temperature has been observed. This is explained by the fast production of zone-center LO phonons by hot electrons combined with slower reabsorption of the emitted phonons due to rapid cooling of Γ valley electrons by intervalley scattering.

33637 Formation of excited hydrogen states in stimulated desorption from an alkali-promoted surface. Johnson, P.D. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973 (USA)); Viescas, A.J.; Nordlander, P.; Tully, J.C. *Physical Review Letters (USA),* 64(8): 942-945 (19 Feb 1990). DOE Contract AC02-76CH00016.

The desorption of hydrogen from alkali-promoted surfaces has been studied with electron-stimulated desorption. Excited hydrogen states are found for work functions that are larger than the binding energies of the corresponding atomic levels. This finding is in direct contrast with the conventional image shift of neutral atomic levels near surfaces and indicates that the levels are instead downshifted near the surface. Calculations of the energy shift and broadening of atomic hydrogen levels in the vicinity of a potassium atom chemisorbed on a metal surface confirms such a downshift. A model is presented that accounts for the observed formation of excited H in ESD from alkali-promoted surfaces.

33638 Roughening phase transition in surface growth. Yan, H. (Department of Physics, Randall Laboratory, The University of Michigan, Ann Arbor, Michigan 48109 (US)); Kessler, D.; Sander, L.M. *Physical Review Letters (USA),* 64(8): 926-929 (19 Feb 1990). DOE Contract FG02-85ER45189.

We present first systematic numerical simulation results which show a strong indication of phase transitions, in *both* 2+1 and 3+1 dimensions, between weak-coupling and strong-coupling regimes in a surface-growth model. A modified ballistic deposition model is used to demonstrate the transitions and the roughness scaling exponent is measured. While the transition in 3+1 dimensions confirms the prediction of the renormalization-group analysis, the one in 2+1 dimensions had not been previously anticipated and exhibits a complex critical behavior.

33639 Bremsstrahlung induced by 50-MeV H^0 bombardment. Stein, C. (Air Force Weapons Laboratory, Kirtland Air Force Base, New Mexico 87117-6008 (USA)); Habiger, K.W.; Smith, B.R.; Crawford, O.H.; Ritchie, R.H. *Physical Review, B: Condensed Matter (USA),* 41(4): 1715-1721 (1 Feb 1990). DOE Contract AC05-84OR21400.

Three different thicknesses of aluminum targets, 0.0025, 0.025, and 0.32 cm were irradiated with 50-MeV neutral hydrogen particles and the resultant bremsstrahlung radiation measured. The experimental results are compared with calculations that include bremsstrahlung by the projectile's electron and its cascade, bremsstrahlung by the cascade electrons that are generated by the projectile nucleus, and quasi-free-electron bremsstrahlung. The theoretical and experimental values of the total yield agree within a factor of 3 for all target thicknesses and all bremsstrahlung energies.

33640 Experimental determination of a species-dependent effect in the transverse emittances of sputter-generated negative-ion beams. Alton, G.D. (Oak Ridge National Laboratory, Post Office Box 2008, Oak Ridge, Tennessee 37831-6368 (US)); Sayer, R.W. *Physical Review, B: Condensed Matter (USA),* 41(4): 1770-1780 (1 Feb 1990). DOE Contract AC05-84OR21400.

We report experimental evidence of a previously unseen species-dependent effect in the transverse emittances of momentum-analyzed $^{28}Si^-$, $^{58}Ni^-$, and $^{197}Au^-$ negative-ion beams generated by cesium-ion sputtering. The differences in the emittances are found to be principally correlated with differences in the energy spreads in the respective ion beams, which have their origins in the sputter-ejection negative-ion formation process. The experimental equipment and techniques utilized for emittance data acquisition and analysis, and evidence for a species-dependent effect in the emittances and brightnesses of the subject ion beams, are presented in this paper.

33641 Diffusion of noninteracting particles into a semi-infinite lattice. Evans, J.W. (Ames Laboratory, Iowa State University, Ames, Iowa 50011 (USA)). *Physical Review, B: Condensed Matter (USA),* 41(4): 2158-2162 (1 Feb 1990). DOE Contract W-7405-ENG-82.

Consider a gas of noninteracting particles diffusing into a semi-infinite lattice, $Z^+ \times Z^{D-1}$, subject to exclusion of double occupancy. An exact closed set of equations can be obtained and solved (in closed form) for the single-site occupancies or densities. Equations for the n-site occupancies couple only to such functions for n and $n-1$ sites, as for an infinite lattice. Their analysis reveals that negative pair correlations develop during this process, reflecting the propensity for diffusion to reduce density inhomogeneities and fluctuations.

33642 Two-state one-dimensional spinless Fermi gas. Freericks, J.K. (Department of Physics, University of California at Berkeley, Berkeley, California 94720 (USA)); Falicov, L.M. *Physical Review, B: Condensed Matter (USA),* 41(4): 2163-2172 (1 Feb 1990). DOE Contract AC03-76SF00098.

The two-state, one-dimensional, spinless Fermi gas (Falicov-Kimball model) is studied exactly by numerical calculation and perturbation theory. Rigorous results are presented for small interaction strength and (restricted) coherent and incoherent phase diagrams are calculated for two specific examples. The numerical calculations are extrapolated to provide a qualitative picture of the complete solution. The result includes a fractal structure in which the ground-state changes discontinuously as a function of the parameters.

33643 Validity and accuracy of multiple-scattering theory. Butler, W.H. (Metals and Ceramics Divsion, Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, Tennessee 37831-6114 (US)). *Physical Review, B: Condensed Matter (USA),* 41(5): 2684-2692 (15 Feb 1990). DOE Contract AC05-84OR21400.

According to a recent paper by Badralexe and Freeman [Phys. Rev. B 37, 10 469 (1988)], multiple-scattering theory (MST) and Korringa-Kohn-Rostoker (KKR) theory do not yield correct solutions to the wave equation. Here, an attempt is made to evaluate this claim by searching for errors in the MST and KKR equations using one- and two-dimensional models. No evidence is found to support the Badralexe-Freeman claim.

33644 A constitutive model for the dynamic response of brittle materials. Addessio, F.L. (Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (USA)); Johnson, J.N. *Journal of Applied Physics (USA),* 67(7): 3275-3286 (1 Apr 1990).

A microphysically based material model for the dynamic inelastic response of a brittle material is developed. The progressive loss of strength as well as the post-failure response of a granular material with friction are included. Crack instability conditions (an inelastic surface in stress space) and inelastic strains are obtained by considering the response of individual microcracks to an applied stress field. The assumptions of material isotropy and an exponential distribution for the crack radius are invoked to provide a tractable formulation. The constitutive model requires a minimal number of physical parameters, is compatible with a previously developed ductile fracture model [J. Appl. Phys. 64, 6699 (1988)] that utilizes inelastic surfaces, and can be formulated as an efficient, robust numerical algorithm for use in three-dimensional computer codes. The material model is implemented into a Lagrangian computer formulation for the demonstration of material response to dynamic loading conditions. Comparisons with one-dimensional, uniaxial impact experiments are provided.

33645 Resonance of the one-dimensional electron transmission above a quantum well with dissipation. Cai, W. (Department of Physics, City College of the City University of New York, New York, New York 10031 (USA)); Hu, P.; Zheng, T.F.; Yudanin, B.; Lax, M. *Physical Review, B: Condensed Matter (USA),* 41(6): 3513-3516 (15 Feb 1990).

We study electron transmission above a quantum well considering the capture effect into a bound state in a quantum well due to dissipation. Our calculation shows a remakable resonance appears when the incident energy nears ω above the bound state, with ω the phonon (photon) energy, no matter how weak dissipation is.

33646 The ionization of thermal and hyperthermal beams of Na, K, and Cs on Si(111) surfaces. Bu, Y. (Chemistry Department, Brown University, Providence, Rhode Island 02912 (US)); Greene, E.F.; Stewart, D.K. *Journal of Chemical Physics (USA),* 92(6): 3899-3908 (15 Mar 1990). DOE Contract FG02-85ER13441.

Measurement of the energy dependence of the yields of Na^+, K^+, and Cs^+ ions formed when beams of the corresponding alkali atoms M hit a Si(111) surface and of Na^+ for Na striking a Pt surface at a temperature T are those expected for equilibrium for thermal kinetic energies E of the incident atoms. Above a threshold energy of 0.5–1.0 eV the yields rise rapidly to maxima greater than 0.1 and then remain approximately constant as the energy increases to 100 eV. They are nearly independent of T in the range 300–1100 K. The results are represented well by a classical model having (1) a rate of electron transfer that varies exponentially with the distance z of M from the surface, (2) potentials that slow the incoming atom down as it nears the surface, and (3) energy transfer by elastic two-body collisions with the surface represented as hard cubes, each having the mass of an integral number n of surface atoms. At z=5 A the rate on Si for Na and K is $10^{12.5\pm0.2}$ s^{-1} with n equal to 3 and 5, respectively, while for Cs it is three times less with n equal to 20. For Na on Pt it is $10^{12.0\pm0.1}$ s^{-1} with n equal to 1.

33647 Reply to "Comment on 'Existence of Wannier-Stark localization' ". Emin, D. (Sandia National Laboratories, Albuquerque, New Mexico 87185-5800 (USA)); Hart, C.F. *Physical Review, B: Condensed Matter (USA),* 41(6): 3859-3861 (15 Feb 1990). DOE Contract AC04-76DP00789.

As Kleinman claims in the preceding Comment, our work indicates that the staircase potential mixes *Bloch states* of different energy bands. However, Wannier-Stark states are superpositions of Bloch states. There is no contradiction with the argument of our work that coherence effects result in each electric-field-dependent energy band forming its own set of Wannier-Stark states.

33648 Landau-Ginzburg model of interphase boundaries in improper ferroelastic Perovskites of D_{4h}^{18} symmetry. Cao, W. (Materials Research Laboratory, The Pennsylvania State University, University Park, PA (USA)— Department of Physics, The Pennsylvania State University, University Park, Pennsylvania 16802 (USA)); Barsch, G.R. *Physical Review, B: Condensed Matter (USA),* 41(7): 4334-4348 (1 Mar 1990). DOE Contract FG02-85ER45214.

The Landau model of Slonczewski and Thomas (1970) for the improper ferroelastic O_h^1-D_{4h}^{18} phase transition in perovskite-structure compounds has been extended by including spatial gradient terms of the three-component primary order parameter (OP) and applied to calculate the OP profile and the strain distribution for antiphase and for twin boundaries in the tetragonal phase. In order to obtain quasi-one-dimensional kink-type solitary-wave solutions for which the OP and the strain depend only on the coordinate normal to the interface plane, lateral surface forces are required which allow for the shape change associated with ferroelastic interfaces, but which prevent expansion or contraction within the boundary plane. Numerical application to $SrTiO_3$, including calculation of the thickness and energy of both types of interphase boundaries versus temperature, is also presented.

33649 Selection rules in resonance electron scattering from adsorbed molecules. Rous, P.J. (Department of Chemistry, University of California at Berkeley, Berkeley, California 94720 (USA)— Center for Advanced Materials, Materials and Chemical Sciences Division, Lawrence Berkeley Laboratory, 1 Cyclotron Road, Berkeley, California 94720 *Physical Review, B: Condensed Matter (USA),* 41(7): 4793-4796 (1 Mar 1990).

We demonstrate the existence of selection rules for resonance electron scattering from adsorbed molecules observed in high-resolution electron-energy-loss spectroscopy which give rise to nodes in the angular distribution of inelastically scattered electrons. These extinctions, which are expected to occur for isolated oriented molecules, survive adsorption—even when the presence of elastic multiple scattering strongly perturbs the angular emission profiles. These nodes occur at fixed angles to the surface normal and are characteristic of both the resonance symmetry and the adsorption geometry. The prospects for using these selection rules to directly determine both the resonance symmetry and the molecular adsorption site are discussed.

33650 Low-temperature epitaxial growth of thin metal films. Evans, J.W. (Department of Physics, Iowa State University, Ames, IA (USA)— Department of Chemistry, Iowa State University, Ames, IA (USA)—Ames Laboratory, Iowa State University, Ames, Iowa 50011 (USA)); Sanders, D.E.; Thiel, P.A.; DePristo, A.E. *Physical Review, B: Condensed Matter (USA),* 41(8): 5410-5413 (15 Mar 1990). DOE Contract W-7405-ENG-82.

We present a different mechanism to explain the occurrence of long-lived oscillations in diffraction spot intensities during epitaxial growth of metal films on fcc (100) substrates at low temperature. Rather than rely on the common picture of cyclical nucleation and growth to produce the oscillations, the model invokes "downward funneling" deposition dynamics to fourfold-hollow adsorption sites.

33651 Electronic modes and infrared optical excitation in tunneling superlattices. Zhang, J. (Department of Physics Astronomy, Ohio University, Athens, OH (USA)—Condensed Matter and Surface Sciences Program, Ohio University, Athens, Ohio 45701-2979 (USA)); Ulloa, S.E.; Schaich, W.L. *Physical Review, B: Condensed Matter (USA),* 41(8): 5467-5470 (15 Mar 1990). DOE Contract FG02-87ER45334.

We present a theoretical study of the far-infrared optical response of a doped tunneling superlattice using the *d*-parameter formalism. Both intra- and interminiband plasma modes as well as single-particle transitions are simultaneously present in the spectra. In addition, a series of novel surface modes related to charge depletion in the superlattice are distinguishable from the corresponding bulk modes, have a significant coupling strength, and are sensitive to details of the depletion-density profile.

6561 Superconductivity

Refer also to citation(s) 32604, 32613, 32660, 32661, 32662, 32664, 32665, 32678, 32681, 32689, 32892, 32897, 32898, 32899, 32900, 32901, 33496

33652 (IC–89/390) Superconductivity in mixed boson-fermion systems. Ioffe, L.; Larkin, A.I.; Ovchinnikov, Yu.N.; Yu, L. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 9p. Order Number DE90627491. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The superconductivity of mixed boson-fermion systems is studied using a simple boson-fermion transformation model. The critical temperature of the superconducting transition is calculated over a wide range of the narrow boson band position relative to the Fermi level. The BCS scenario and boson condensation picture are recovered in two limiting cases of high and low positions of boson band, respectively, with modifications due to boson-fermion interaction. (author). 11 refs.

33653 (IC–89/426) Pairing with fractional angular and "spinor" gap. Khveshchenko, D.V. (International Centre for Theoretical Physics, Trieste (Italy)); Kogan, Y.I. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 10p. Order Number DE90627492. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

We study a two-dimensional model, where a multivalued superconducting order parameter arises. Flux quantization and the Josephson effect are discussed. (author). 7 refs.

33654 (IC–89/427) Parity violation and superconductivity in doped Mott insulators. Khveshchenko, D.V. (International Centre for Theoretical Physics, Trieste (Italy)); Kogan, Ya.I. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 45p. Order Number DE90627493. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We study parity violating states of strongly correlated two-dimensional electronic systems. On the basis of mean field theory for the SU(2N)-symmetric generalization of the system involved we give the arguments supporting the existence of these states at a filling number different from one-half. We derive an effective Lagrangian describing the long wavelength dynamics of magnetic excitations and their interaction with charged spinless holes. We establish that the ground state of a doped system is superconducting and discuss the phenomenological manifestations of the parity violation. (author). 48 refs, 3 figs.

33655 (PB–90-183385/XAB) **Progress in facilitating access to science and technology, highlighting superconductivity.** Office of Science and Technology Policy, Washington, DC (USA). Jun 1988. 80p. Available from NTIS, PC A05/MF A01.

The President's Superconductivity Initiative of July 28, 1987, requires that the Science Adviser to the President report on progress in implementing the April 10, 1987, Executive Order 12591, Facilitating Access to Science and Technology, particularly in regard to superconductivity. Recent discoveries in high temperature superconducting materials may provide a unique opportunity for Government-academic-business cooperation in the rapid development of this exciting scientific phenomenon. The report focuses on select examples of progress to assess overall responses to Executive Order 12591. A more comprehensive and detailed evaluation will be part of the task force study and report.

33656 **The state of the industry.** Kaufmann, E.N. (Argonne National Lab., IL (USA)); Riesen, A.E.; Shaw, D.T.; Cannon, P.; Mead, E. J. *Superconductor Industry (USA),* 3(1): 22-33 (1990).

This article reports on the current state of the superconductor industry. The authors express their opinions regarding industry-wide progress in understanding of and applications for superconductors. The role of the U.S. government in research and development is addressed and the international competition within the superconducting industry is discussed.

33657 **Positron-annihilation momentum density in superconductors.** Benedek, R. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439 (USA)); Schuettler, H. *Physical Review, B: Condensed Matter (USA),* 41(4): 1789-1796 (1 Feb 1990). DOE Contract W-31109-ENG-38.

The origin of the dramatic shifts observed in the temperature dependence of positron-annihilation characteristics (particularly lifetime and Doppler-broadening line shape) near T_c in the cuprates is not presently clear. Both intrinsic and extrinsic (i.e., defect-related) mechanisms have been proposed. To help clarify whether Cooper pairing is responsible for these shifts, we present an approximate formulation of the positron characteristics in a BCS superconductor. Relations are derived for the zeroth- and first-order terms in the ladder summation for the two-photon momentum density, with electron propagators represented in the Nambu-Gorkov form. The momentum densities in the normal and superconducting states differ appreciably only within the pairing shell centered at p_F. Numerical calculations are performed for two- and three-dimensional models. The differences increase with increasing Δ/μ but are relatively small in the first-order calculation. We also estimate an upper bound to the effect of BCS pairing on the positron characteristics, including terms to all orders in the electron-positron interaction. Based on comparisons of our model calculations with experiment, it seems unlikely that BCS pairing is responsible for the measured shifts in positron properties near T_c.

33658 **Phenomenological model of the copper oxide superconductors.** Klemm, R.A. (Ames Laboratory and Department of Physics, Iowa State University, Ames, Iowa 50011 (US)). *Physical Review, B: Condensed Matter (USA),* 41(4): 2073-2097 (1 Feb 1990). DOE Contract W-7405-ENG-82.

We propose a phenomenological model for the copper oxide superconductors in which one complex *s*-wave order parameter (OP) is associated with each of the N conducting layers per unit cell, with $N-1$ equal spacings d and one different spacing d'; the c axis repeat distance $s=d'+(N-1)d$. The layers are coupled by Josephson-like tunneling, with parameters ζ_1 and ζ_2, respectively. The Gaussian fluctuation free energy is diagonalized, yielding N distinct T_c values. Just above the highest T_c, the fluctuations are usually dominated by the three-dimensional (3D) regime of a single cellular OP. In the 2D regime further above T_c, more of the OP's contribute to the fluctuations, their relative contributions depending upon the ζ_1 and ζ_2 values. The temperature (T) and angular (θ) dependence of the resulting fluctuation magnetization $\mathbf{M}(\theta,T)$ is calculated.

33659 **One-dimensional narrow-band model for heavy fermions and resonating valence bonds.** Schlottmann, P. (Department of Physics, Temple University, Philadelphia, Pennsylvania 19122 (USA)). *Physical Review, B: Condensed Matter (USA),* 41(7): 4164-4172 (1 Mar 1990). DOE Contract FG02-87ER45333.

A one-dimensional-lattice model consisting of a single narrow band and excluded double occupancy of the sites is considered. The electrons on nearest-neighbor sites interact via a charge interaction and spin exchange. In a previous paper we discussed the exact solution of the model for special values of the coupling constants [related to SU(3) invariance]. Here we construct an asymptotically exact solution in the low-electron-density limit for coupling parameters deviating from SU(3) symmetry. The results are compared to those obtained via multiplicative renormalization for the model in the continuum limit and used to discuss the phase diagram.

33660 **Universal reduction of T_c in strong-coupling superconductors by a small concentration of magnetic impurities.** Jarrell, M. (The Ohio State University, Columbus, Ohio 43210 (USA)). *Physical Review, B: Condensed Matter (USA),* 41(7): 4815-4818 (1 Mar 1990).

The first exact calculation of T_c in the presence of a dilute concentration c of uncorrelated magnetic impurities is presented. The shape of $T_c(c)$ is universal, $T_c(c)/T_{c0} = h[cf(\lambda_0)/N(0)T_{c0}, T_K/T_{c0}]$. The detailed shape of $T_c(c)/T_{c0}$ is qualitatively and quantitatively different from that found by previous approximate theories. $T_c(c)$ depends strongly upon the electron-phonon coupling λ_0. There is no indication of a low-temperature tail of positive curvature for $T_K/T_{c0}<1$, or the associated third transition temperature T_{c3}, both predicted by Mueller-Hartmann and Zittartz. My results agree well with experimental data.

6570 Theoretical and Mathematical Physics

Refer also to citation(s) 32529, 32767, 33036, 33285, 33286, 33322, 33511, 33515, 33620, 33621, 33789

33661 (CBPF-NF–029/89) **On BRST quantization of chiral bosonic particle.** Srivastava, P.P. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 12p. Order Number DE90627174. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A chiral bosonic particle based on a linear constraint, in analogy to a recently proposed similar description for chiral boson, is quantized and its propagator obtained. (author).

33662 (CBPF-NF–030/89) **Geometrical properties of an internal local octonionic space in a non-Riemannian manifold.** Marques-Bonham, S. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 22p. Order Number DE90627175. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

It is summarized a geometrical treatment on a flat tangent space local to a generalized complex, quaternionic, and octonionic spacetime. (auThor).

33663 (CBPF-NF–037/89) **On the ζ-function regularization of chiral Jacobians for singular Dirac operators.** Carneiro, C.E.I. (Sao Paulo Univ., SP (Brazil). Inst. de Fisica); Thomas, M.T.; Dias, S.A. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 25p. Order Number DE90627176. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A definition of the chiral Jacobian which uses the invariance of the generating functional under chiral rotarions is proposed. This definition takes into account the contributions of all terms which after the rotation, get a dependence on the chiral parameter α. It is shown that, when the Dirac operator has zero eigenvalues the presence of fermionic sources gives an additional dependence on α. The proposed definition, by considering this α-dependence, reconciles the ζ-function method of calculating chiral Jacobians with Fujikawa's. (author).

33664 (CBPF-NF–048/89) **Dirac's equation as a geodesic in Riemann space.** Lopes, J.L. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 10p. Order Number DE90627194. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Dirac's equation is derived from a geometrical variational principle which involves a line-element matrix in flat space (for a free fermion and for a fermion in interaction with a gauge field) or a in Riemann space (for a fermion in interaction with the spinor connection, the gauge field of the local Lorentz group). (author).

33665 (CBPF-NF–050/89) **Casimir effect in a d-dimensional flat spacetime and the cut-off method.** Svaiter, N.F. (Rio de Janeiro Univ., RJ (Brazil)); Svaiter, B.F. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 23p. Order Number DE90627177. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The CasiMir effect in a D-dimensional spacetime produced by a Hermitian massless scalar field in the presence of a pair of perfectly reflecting parallel flat plates is discussed. The exponential cut-off regularization method is employed. The regularized vacuum energy and the Casimir energy of this field are evaluated and a detailed analysis of the divergent terms in the regularized vacuum energy is carried out. The two-dimensional version of the Casimir effect is discussed by means of the same cut-off method. A comparison between the above method and the zeta function regularization procedure is presented in a way which gives the unification between these two methods in the present case. (author).

33666 (CRN-HE–88-04) **Beyond spinors.** Rausch Traubenberg, M. de; Fleury, N. Strasbourg-1 Univ., 67 (France). Centre de Recherches Nucleaires. 1988. 24p. Order Number DE90792991. Available from NTIS (US Sales Only), PC A03/MF A01.

We propose an extension of spinors, called metaspinors, in space with any number of dimensions. Metaspinors are interpreted as a representation of the symmetry group that leaves a given homogeneous forms of degree n invariant. First, we study two kinds of homogeneous forms and the symmetry groups associated. Only one of these allows to define n-metaspinors. We next find two sets of nxn matrices associated with the two previous forms which could be an extension of Pauli matrices. Assuming n-metaspinors to be a n-complex vectorial space with a peculiar n-metric, we also characterize states of metaspinors and introduce the metaspin. From the study of metaspinorial tensors, we prove that they reduce to vectors. From n-metaspinors, if the dimension is n = pk, we can define p-metaspinors. Finally, we give the dynamical evolution of metaspinors, on the classical level with Dirac and Bargmann-Wigner-Like equations and on the quantic one with path integral formulation. At each step of the calculations, when n = 2, metaspinors reproduce the results of ordinary spinors.

33667 (CRN-HE–88-07) **Jordan algebras and flat potentials at one loop.** Savoy, C.A. (Fermi National Accelerator Lab., Batavia, IL. (US)). Strasbourg-1 Univ., 67 (France). Centre de Recherches Nucleaires. 1988. 20p. Order Number DE90792990. Available from NTIS (US Sales Only), PC A03/MF A01.

Supergravity models with a vanishing scalar potentials along one or more directions of the fields have been constructed which are closely related to the well-known Jordan algebras. Their interesting geometrical and physical properties are discussed. The one-loop quantum corrections to the scalar potential are determined and studied also after the addition of some superstring inspired supersymmetry breaking terms.

33668 (IC–89/277) **Continuum states of the Klein-Gordon equations for vector and scalar interactions.** Talukdar, B.; Yunus, A.; Amin, M.R. International Centre for Theoretical Physics, Trieste (Italy). Nov 1989. 7p. Order Number DE90627178. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The scattering states solutions of the s-wave Klein-Gordon equation with vector and scalar Hulthen type potentials are obtained both for regular and irregular boundary conditions. The Coulomb limit of these results is examined and the s-wave Hulthen problem is related to the l-wave Coulomb problem. Explicit expressions are constructed for the associated Jost functions, which play a role in determining the redundant states of the S matrix. (author). 10 refs.

33669 (IC–89/329) **On Einsteinian 4-submanifolds in E^6.** Zafindratafa, G. International Centre for Theoretical Physics, Trieste (Italy). Nov 1989. 11p. Order Number DE90627149. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This work contributes to the classification of some Einsteinian 4-submanifolds by determining the second fundamental form. This leads to a characterization of some flat submanifolds of the Euclidean space. In particular, we show that an N-codimensional flat submanifold with flat normal connection in E^{n+N} is cylindrical. Such a result is important since, in 1919, Elie Cartan asserted without proof the existence of flat, non cylindrical submanifolds of dimension $n \geq 4$ in E^{n+N}; at the same time he proved than an n-dimensional submanifold of E^{n+N}, $n \leq 3$, is flat if and only if it is cylindrical. (author). 12 refs.

33670 (IC–89/342) **An instability theorem for a certain sixth order differential equation.** Tiryaki, A. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 5p. Order Number DE90627150. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

In the present paper we try to establish an instability theorem for the trivial solution of the sixth order differential equations. 3 refs.

33671 (IC–89/379) **A comment on anisotropic spheres admitting one parameter group of conformal motions.** Bokhari, A.H. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 7p. Order Number DE90627195. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

An earlier solution of the Einstein field equations for spherically symmetric distributions of anisotropic matter (principle stresses unequal) is modified, assuming the existence of a one parameter group of conformal motions. It is shown that the modified solution yields a more general expression of the spacetime metric which includes the earlier metric as a special case. The solution is matched across a separating hypersurface with the Schwarzschild solution. It turns out that the expression for the line element corresponding to the induced metric on the boundary, from the inside, makes geometry look significantly different from the one obtained earlier. (author). 2 refs.

33672 (IC–89/388) **Dissipative quantum maps.** Cerdeira, H.A.; Ramaswamy, R. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 22p. Order Number DE90627179. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We study a quantum kicked oscillator system in contact with a heat bath. The periodic forcing allows us to define a quantum map. Using the Caldeira-Leggett approach, we solve for the kernel of the Wigner function. We define the Lyapunov exponent for this quantum system by computing the expectation value for the coordinate variable. This is achieved by taking the average along a semiclassical trajectory weighted by the Wigner function. (author). 20 refs, 6 figs.

33673 (IC–89/392) **Propagation of electromagnetic radiation in a random field of gravitational waves and space radio interferometry.** Braginsky, V.B. (Moskovskij Gosudarstvennyj Univ., Moscow (USSR)); Kardashev, N.S.; Polnarev, A.G.; Novikov, I.D. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 26p. Order Number DE90627196. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Propagation of an electromagnetic wave in the field of gravitational waves is considered. Attention is given to the principal difference between the electromagnetic wave propagation in the field of random gravitational waves and the electromagnetic wave propagation in a medium with a randomly-inhomogeneous refraction index. It is shown that in the case of the gravitation wave field the phase shift of an electromagnetic wave does not increase with distance. The capability of space radio interferometry to detect relic gravitational waves as well as gravitational wave bursts of non cosmological origin are analyzed. (author). 64 refs, 2 figs.

33674 (IC–89/394) **Quantum chaos and dissipation: Lyapunov exponents.** Cerdeira, H.A. (International Centre for Theoretical Physics, Trieste (Italy)); Ramaswamy, R.; Caldeira, A.O. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 19p. Order Number DE90627180. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We study a periodically kicked quantum oscillator system in contact with a heat bath. Using the Caldeira-Leggett approach, we

solve for the kernel of the Wigner function at all temperatures. Previous results for dissipative quantum maps are recovered as special limits of low damping and slow kicks when the system effectively becomes one-dimensional. We then define the Lyapunov exponent for this quantum system by computing the expectation value for the coordinate variable, by taking the average along a semiclassical trajectory weighted by the Wigner function. In the semiclassical limit, the Lyapunov exponent scales as a positive exponent of Planck's constant. (author). 19 refs, 6 figs.

33675 (IC–89/395) **Uniform dissipative solutions for some fourth order nonlinear differential equations.** Afuwape, A.U. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 18p. Order Number DE90627151. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In this paper, we shall apply the frequency domain method to prove that the solutions of some fourth order nonlinear differential equations are uniformly dissipative. This extends the applications of earlier results. (author). 18 refs.

33676 (IC–89/396) **An existence theorem for periodic solutions and applications to some third order nonlinear differential equations.** Afuwape, A.U. (International Centre for Theoretical Physics, Trieste (Italy)); Zanolin, F. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 24p. Order Number DE90627152. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In this paper, we prove an existence theorem for periodic nonlinear ordinary differential equations with one-sided growth restrictions. Applications are given to some nonlinear third order differential equations. Earlier results of Ezeilo and Nkashama are thus extended. (author). 21 refs.

33677 (IC–89/397) **Weighted norm inequalities for Riemann-Liouville fractional integral.** Imoru, C.O. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 16p. Order Number DE90627153. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The main objective of this paper is to prove a result which is more general than the theorem on weighted inequalities for Riemann-Liouville fractional integrals of order n ($n \geq 1$) proved by Martin-Reyes and Sawyer. 5 refs.

33678 (IC–89/398) **On comparable L^p-norms of subadditive functions on topological groups.** Imoru, C.O. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 7p. Order Number DE90627154. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

In this paper we prove a theorem which contains, as a special case, a result of Beesack on comparable L^p-norms of subadditive functions. (author). 3 refs.

33679 (IC–89/410) **The center of the enveloping algebra of the semidirect product of the Heisenberg Lie algebra h_n and a reductive lie algebra S the rank of which is equal to 1 or 2.** Le Van Hop. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 22p. Order Number DE90627155. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Computational methods and some theoretical results about polynomial algebras in several variables (and especially in 2 variables) are used to determine the center of the enveloping algebra of the semidirect product of the Heisenberg Lie algebra and a reductive Lie algebra the rank of which is equal to 1 or 2. (author). 9 refs.

33680 (IC–89/411) **Recurrence relations and weight functions for approximation by orthonormal polynomials.** Bisoi, A.K. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 9p. Order Number DE90627156. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The popular three-term recurrence relation is found to be a numerically unstable algorithm for generation of higher order orthogonal polynomials. For stability, a k-term recurrence relation for generating the k th order polynomial is suggested. Instead of assigning equal weight to data points with unspecified errors, the use of the Jacobian weight function is suggested for generating the orthogonal polynomials to effect a closer representation. (author). 6 refs, 1 tab.

33681 (IC–89/412) **Beltrami algebra and symmetry of Beltrami equation on Riemann surfaces.** Guo Hanying (International Centre for Theoretical Physics, Trieste (Italy)); Xu Kaiwen; Shen Jianmin; Wang Shikun. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 16p. Order Number DE90627157. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

It is shown that the Beltrami equation has an infinite dimensional symmetry, namely the Beltrami algebra, on its solution spaces. The Beltrami algebra with central extension and its supersymmetric version are explicitly found. (author). 12 refs.

33682 (IC–89/422) **Product integration rules at Clenshaw-Curtis and related points: A robust implementation.** Adam, G.; Nobile, A. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 35p. Order Number DE90627158. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Product integration rules generalizing the Fejer, Clenshaw-Curtis and Filippi quadrature rules respectively are derived for integrals with trigonometric and hyperbolic weight factors. The study puts in evidence the existence of well-conditioned fully analytic solutions, in terms of hypergeometric functions ${}_0F_1$. An a priori error estimator is discussed which is shown both to avoid wasteful invocation of the integration rule and to increase significantly the robustness of the automatic quadrature procedure. Then, specializing to extended Clenshaw-Curtis (ECC) rules, three types of a posteriori error estimates are considered and the existence of a great risk of their failure is put into evidence by large scale validation tests. An empirical error estimator, superseding them at slowly varying integrands, is found to result in a spectacular increase in the output reliability. Finally, enhancements in the control of the interval subdivision strategy aiming at increasing code robustness is discussed. Comparison with the code DQAWO of QUADPACK, extending over a statistics of about hundred thousand solved integrals, is illustrative for the increased robustness and error estimate reliability of our computer code implementation of the ECC rules. (author). 19 refs, 8 tabs.

33683 (IC–89/425) **Old and new ideas in the theory of quantum measurement.** Ghirardi, G.C. (International Centre for Theoretical Physics, Trieste (Italy)); Rimini, A. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 27p. Order Number DE90627181. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This work deals with an attempt at incorporating the definite and local character of macroscopic objects in the principles of quantum mechanics and describing reduction as a real physical process, thereby recovering the textbook interpretation of the wave function. 25 refs, 1 tab.

33684 (IC–89/428) **Oscillatory and nonoscillatory behaviour of solutions of an equation alternately of retarded and advanced type.** Parhi, N. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 15p. Order Number DE90627159. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Sufficient conditions have been obtained for oscillation and nonoscillation of solutions of a nonlinear differential equation which is alternately of retarded and advanced type. (author). 7 refs.

33685 (IC–89/432) **Periodic solutions of certain fifth order differential equations.** Tiryaki, A. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 10p. Order Number DE90627160. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

In this paper, the sufficient conditions for the existence of periodic solutions of the certain fifth order differential equations are given. 6 refs.

33686 (IC–89/434) **The combinatorics computation for Casimir operators of the symplectic Lie algebra and the application for determining the center of the enveloping algebra of a semidirect product.** Le Van Hop. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 39p. Order Number DE90627161. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The combinatorics computation is used to describe the Casimir operators of the symplectic Lie Algebra. This result is applied for

determining the Center of the enveloping Algebra of the semidirect Product of the Heisenberg Lie Algebra and the symplectic Lie Algebra. (author). 10 refs.

33687 (IC–90/3) **Solution of the Stokes system by boundary integral equations and fixed point iterative schemes.** Chidume, C.E. (Nigeria Univ., Nsukka (Nigeria). Dept. of Mathematics); Lubuma, M.S. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 20p. Order Number DE90627166. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The solution to the exterior three dimensional Stokes problem is sought in the form of a single layer potential of unknown density. This reduces the problem to a boundary integral equation of the first kind whose operator is the velocity component of the single layer potential. It is shown that this component is an isomorphism between two appropriate Sobolev spaces containing the unknown densities and the data respectively. The isomorphism corresponds to a variational problem with coercive bilinear form. The latter property allows us to consider various fixed point iterative schemes that converge to the unique solution of the integral equation. Explicit error estimates are also obtained. The successive approximations are also considered in a more computable form by using the product integration method of Atkinson. (author). 47 refs.

33688 (IC–90/4) **The Cousin problems for an overdetermined system of complex partial differential equations.** Le Hung Son. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 8p. Order Number DE90627170. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

In this paper, the Cousin Problems for an Overdetermined System of complex Partial Differential Equations are considered. It is proven that, under suitable hypotheses on its coefficients, the Cousin Problems can be solved on the domains of C^n, which satisfy the same conditions as those in Complex Analysis. (author). 6 refs.

33689 (IC–90/9) **The Cousin problems in the viewpoint of partial differential equations.** Le Hung Son. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 18p. Order Number DE90627172. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In this paper we consider the Cousin problems for overdetermined systems of partial differential equations, which are generalizations of the Cauchy-Riemann system. The general methods for solving these problems are given. Applying the given methods we can solve the Cousin problems for many important systems in theoretical physics. (author). 19 refs.

33690 (IC–90/10) **Some overdetermined systems of complex partial differential equations.** Le Hung Son. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 13p. Order Number DE90627162. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In this paper we extend some properties of analytic functions on several complex variables to solutions of overdetermined systems of complex partial differential equations. It is proved that many global properties of analytic functions are true for solutions of the Vekua system in special cases. The relation between analytic functions and solutions of quasi-linear systems is discussed in the paper. (author). 8 refs.

33691 (IC–90/13) **On an isospectrality question over compact Riemann surfaces.** Srinivas Rau, S. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 5p. Order Number DE90627163. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

It is proved that for a generic compact Riemann surface X of genus $g>1$,(i) there are at most 2^{2g} unitary characters of $\pi_1(X)$ whose associated line bundles have laplacians of identical spectrum, (ii) generating cycles for $\pi_1(X)$ can be chosen to be closed geodesics whose length multiplicity is 1. (author). 5 refs.

33692 (IC–90/14) **A corollary to Kodaira-Spencer's theorem on continuity of eigenvalues.** Srinivas Rau, S. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 10p. Order Number DE90627164. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

We give an elementary proof of continuity of the determinant in the parameter for a smooth family of laplacians (of the same nullity) on a smooth family of holomorphic vector bundles over a compact complex manifold. Families of unitary flat bundles over a compact Riemann surface are discussed, as an example. (author). 8 refs.

33693 (IC–90/16) **Asymptotics of Laplace-Dirichlet integrals.** Kozlov, S.M. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 7p. Order Number DE90627165. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Here we consider the problem of the asymptotic expansion of the Laplace-Dirichlet integral. In homogenization theory such an integral represents the energy, and in general depends on the cohomology class. Here the asymptotic behaviour of this integral is found. The full text will appear in Functional Analysis and Applications, 1990, No.2. (author). 3 refs.

33694 (IC–90/17) **Unexpected properties of the centrifugal force.** Abramowicz, M.A. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 24p. Order Number DE90627197. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Contrary to what is stated in the Newtonian dynamics, rotation of a reference frame is not sufficient for the occurrence of the centrifugal force. Instead, the necessary and sufficient condition is a motion along a path different from that of a photon trajectory in space. This calls for a rather fundamental change in understanding of the very nature of the centrifugal force. It also has important practical physical consequences: in a strong gravitational field, where light trajectories are substantially curved, centrifugal force is much weaker than the Newtonian theory predicts. In addition, when there are closed (circular) photon trajectories in space, the centrifugal force may reverse its direction - it attracts towards the rotation axis{ exclamation_point} . The weakening of the centrifugal force in strong gravitational fields and the reversal of its direction in the neighbourhood of close photon trajectories in space fully and clearly explain puzzling examples of counter intuitive behaviour of dynamical effects of rotation found previously by several authors: e.g. reversal of the ellipticity behaviour of the relativistic Maclaurin spheroids (Chandrasekhar and Miller, 1974), reversal of the viscous torque action (Anderson and Lemos, 1988), or the fact that rotation increases internal pressure of a sufficiently compact star (Abramowicz and Wagoner, 1974). Weakening of the centrifugal force implies that rotating neutron stars are less oblate (and probably more stable) than the Newtonian theory predicts. This is important for the recently discussed question of how fast can pulsars spin. (author). 23 refs, 3 figs.

33695 (IC–90/19) **Does nature place a fundamental limit on strength?.** Lee, S.C. (National Univ. of Singapore (Singapore). Dept. of Physics); Shiekh, A.Y. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 6p. Order Number DE90627198. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A fundamental limit on the stress to density ratio is determined solely from the theory of special relativity and the principle of the conservation of energy. (author). 7 refs.

33696 (IC–90/23) **On a calculation of the ground-state energy in quantum mechanics.** Efimov, G.V. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 21p. Order Number DE90627182. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In nonrelativistic quantum mechanics the Wick-ordering method called the oscillator representation is suggested to calculate the ground-state energy for a wide class of potentials allowing the existence of a bound state. This method is especially effective for the potentials which are "strong" in some sense and the standard perturbation theory is not applicable. Several examples are considered. (author). 9 refs, 3 figs.

33697 (IC–90/31) **A remark on Euclidean-domain types.** Alemu, Y. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 19p. Order Number DE90627167. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A necessary and sufficient condition for the ring of integers of a finite separable extension of the quotient field of a Euclidean domain to be a unique factorization domain is developed. Since

Number Fields are of such a type, an application is demonstrated using the complex quadratic fields. (author). 5 refs.

33698 (IC–90/34) **The location of zeros using generalizations of Newton's method.** Uko, L.U. International Centre for Theoretical Physics, Trieste (Italy). Feb 1990. 12p. Order Number DE90627168. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We study generalizations of Newton's method which terminate quadratically under adequate conditions and are occasionally faster than the standard Newton schemes. These methods also apply to problems involving functions which are not sufficiently regular to allow for the application of the classical method of Newton. In particular, the generalized schemes can be used to solve variational inequalities. Numerical examples are given. (author). 13 refs.

33699 (IC–90/35) **An error estimate for Tremolieres method for the discretization of parabolic variational inequalities.** Uko, L.U. International Centre for Theoretical Physics, Trieste (Italy). Feb 1990. 8p. Order Number DE90627169. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

We study a scheme for the time-discretization of parabolic variational inequalities that is often easier to use than the classical method of Rothe. We show that if the data are compatible in a certain sense, then this scheme is of order $\geq 1/2$. (author). 10 refs.

33700 (IC–90/39) **On the dimensional reduction of a gravitational theory containing higher-derivative terms.** Pollock, M.D. International Centre for Theoretical Physics, Trieste (Italy). Feb 1990. 15p. Order Number DE90627199. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

From the higher-dimensional gravitational theory L-circumflex=R-circumflex-2Λ-circumflex-α-circumflex$_1$ R-circumflex^2=α-circumflex$_2$R-circumflex$_{AB}$R-circumflex^{AB} -α-circumflex$_3$R-circumflex$_{ABCD}$R-circumflex^{ABCD}, we derive the effective four-dimensional Lagrangian L. (author). 12 refs.

33701 (IC–90/40) **The symplectic structure of submanifolds of Kaehler manifolds of non-positive curvature.** Ciriza, E. International Centre for Theoretical Physics, Trieste (Italy). Feb 1990. 18p. Order Number DE90627171. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

McDuff proved that the Kaehler form ω on a simply connected complete Kaehler 2n-dimensional manifold P of non-positive curvature is diffeomorphic to the standard symplectic form ω_0 on R^{2n}. We show that the symplectomorphism she constructed takes a totally geodesic symplectic submanifold Q into a symplectic linear subspace of R^{2n}. She also proved that if L is a totally geodesic Lagrangian submanifold (P,ω) then P is symplectomorphic to the cotangent bundle T*L with its usual symplectic structure. We extend this result to the case of totally geodesic isotropic submanifolds of P. (author). 8 refs.

33702 (IFT-P–27/89) **Symplectic bosons, Fermi fields and super Jordan algebras.** Ferreira, L.A.; Gomes, J.F.; Teotonio Sobrinho, P.; Zimerman, A.H. Instituto de Fisica Teorica (IFT), Sao Paulo, SP (Brazil). 1989. 18p. Order Number DE90627183. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A construction relating the structures of Super Lie and Super Jordan algebras is proposed. This may clarify the role played by field theoretic realizations of Super Jordan algebras in the construction of representations of Super Kac-Moody algebras. The case of OSP (m,n) and Super Clifford algebras involving independent Fermi fields and Simplectic bosons is discussed in detail. (author).

33703 (IFT-P–28/89) **Squeezed states representation; an λ-expansion of statistical mechanics.** Mizrahi, S.S. (Sao Carlos Univ., SP (Brazil). Dept. de Fisica); Galetti, D. Instituto de Fisica Teorica (IFT), Sao Paulo, SP (Brazil). 1989. 11p. Order Number DE90627184. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

An alternative semiclassical approach (to the Wigner-Kirkwood Method) that makes use of the Squeezed States Space Representation is derived. As an illustration, some statistical mechanics formulae are writtten as an λ-expansion. (author).

33704 (IFT-P–29/89) **On the structure of quantum phase space.** Aldrovandi, R.; Galetti, D. Instituto de Fisica Teorica (IFT), Sao Paulo, SP (Brazil). 1989. 44p. Order Number DE90627185. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The space of labels characterizating the elements of Schwinger's basis for unitary quantum operators is endowed with a structure of symplectic type. This structure is embodied in a certain algebric cocycle, whose main features are inherited by the symplectic form of classical phase space. In consequence, the label space may be taken as the Quantum Phase Space Space: it plays, in the quantum case, the same role played by phase in classical mechanics, some differences coming inevitably from its non-linear character. (author).

33705 (INS–798) **BRS invariant stochastic quantization of Einstein gravity.** Nakazawa, Naohito. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Nov 1989. 35p. Order Number DE90791126. Available from NTIS (US Sales Only), PC A03/MF A01.

We study stochastic quantization of gravity in terms of a BRS invariant canonical operator formalism. By introducing artificially canonical momentum variables for the original field variables, a canonical formulation of stochastic quantization is proposed in the sense that the Fokker-Planck hamiltonian is the generator of the fictitious time translation. Then we show that there exists a nilpotent BRS symmetry in an enlarged phase space of the first-class constrained systems. The phase space is spanned by the dynamical variables, their canonical conjugate momentum variables, Faddeev-Popov ghost and anti-ghost. We apply the general BRS invariant formulation to stochastic quantization of gravity which is described as a second-class constrained system in terms of a pair of Langevin equations coupled with white noises. It is shown that the stochastic action of gravity includes explicitly the De Witt's type superspace metric which leads to a geometrical interpretation of quantum gravity analogous to nonlinear σ-models. (author).

33706 (KFKI–1989-52/B) **On the minimum uncertainty of space-time geodesics.** Diosi, L.; Lukacs, B. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Oct 1989. 15p. Order Number DE90627203. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Although various attempts for systematic quantization of the space-time geometry ('gravitation') have appeared, none of them is considered fully consistent or final. Inspired by a construction of Wigner, the quantum relativistic limitations of measuring the metric tensor of a certain space-time were calculated. The result is suggested to be estimate for fluctuations of g_{ab} whose rigorous determination will be a subject of a future relativistic quantum gravity. (author) 11 refs.

33707 (KFKI–1989-53/A) **Strong coupling analogue of the Born series.** Dolinszky, T. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Oct 1989. 44p. Order Number DE90627187. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Phys. Rev., A (NL).

In a given partial wave, the strength of the centrifugal term to be incorporated into the WKBA solutions in different spatial regions can be adjusted so as to make the first order wave functions everywhere smooth and, in strong coupling, exactly reproduce Quantum Mechanics throughout the space. The relevant higher order approximations supply an absolute convergent series expansion of the exact scattering state. (author) 4 refs.; 2 figs.; 2 tabs.

33708 (KFKI–1989-55/B) **Some notes on stationary vacuum space-times with shearing nongeodesic eigenrays.** Horvath, I.; Lukacs, B. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Oct 1989. 23p. Order Number DE90627204. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

An interesting task in general relativity is to look for external solutions of compact final states of stellar evolution, such as rotating neutron stars and black holes, when Newtonian treatment is already insufficient. The stationary vacuum problem with eigenray structure of κ=const and σ=const and nonzero is considered, as a

possible Kerr generalisation. The result is that for the solutions of the Einstein equation this class is empty. (author) 11 refs.

33709 (LNCC–041/88) **Applications of mixed Petrov-Galerkin finite element methods to transient and steady state creep analysis.** Guerreiro, J.N.C.; Loula, A.F.D. Laboratorio Nacional de Computacao Cientifica (LCC), Rio de Janeiro, RJ (Brazil). Dec 1988. 26p. Order Number DE90627188. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The mixed Petrov-Galerkin finite element formulation is applied to transiente and steady state creep problems. Numerical analysis has shown additional stability of this method compared to classical Galerkin formulations. The accuracy of the new formulation is confirmed in some representative examples of two dimensional and axisymmetric problems. (author).

33710 (LNCC–044/88) **Finite element analysis of nonlinear creeping flows.** Loula, A.F.D.; Guerreiro, J.N.C. Laboratorio Nacional de Computacao Cientifica (LCC), Rio de Janeiro, RJ (Brazil). Dec 1988. 36p. Order Number DE90627189. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Steady-state creep problems with monotone constitutive laws are studied. Finite element approximations are constructed based on mixed Petrov-Galerkin formulations for constrained problems. Stability, convergence and a priori error estimates are proved for equal-order discontinuous stress and continuous velocity interpolations. Numerical results are presented confirming the rates of convergence predicted in the analysis and the good performance of this formulation. (author).

33711 (LNCC–048/88) **Dual and primal mixed Petrov-Galerkin finite element methods in heat transfer problems.** Loula, A.F.D.; Toledo, E.M. Laboratorio Nacional de Computacao Cientifica (LCC), Rio de Janeiro, RJ (Brazil). Dec 1988. 16p. Order Number DE90627190. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

New mixed finite element formulations for the steady state heat transfer problem are presented with no limitation in the choice of conforming finite element spaces. Adding least square residual forms of the governing equations of the classical Galerkin formulation the original saddle point problem is transformed into a minimization problem. Stability analysis, error estimates and numerical results are presented, confirming the error estimates and the good performance of this new formulation. (author).

33712 (LYCEN–89-11) **A new short range gravitational force in the leptonic world.** Elbaz, E. (Lyon-1 Univ., 69 - Villeurbanne (FR). Inst. de Physique Nucleaire); Novello, M. Lyon-1 Univ., 69 - Villeurbanne (France). Inst. de Physique Nucleaire. Apr 1989. 17p. Order Number DE90793000. Available from NTIS (US Sales Only), PC A03/MF A01.

We use Grishchuk's approach to introduce Gravitation via a rank-two symmetric tensor field in a flat space-time. We then examine the consequences of a non-identical coupling of gravity with electrons and neutrinos. We show that a local counterpart of the gravitational interaction must occur, mediated by massive spin-two tensor bosons. A universal Higgs mechanism thus determine the mass of these bosons.

33713 **Gravity and antimatter.** Goldman, T.; Hughes, R.J.; Nieto, M.M. *Scientific American (USA),* 258(3): 48-56 (Mar 1988).

No one has ever dropped a single particle of antimatter. Yet physicists assume that it would fall to the ground just like ordinary matter. Their arguments are based on two well established ideas: the equivalence principle of gravitation and the quantum-mechanical symmetry between matter and antimatter. Today this line of reasoning is being undermined by the possibility that the first of these ideas, the principle of equivalence, may not be true. Indeed all modern attempts to include gravity with the other forces of nature in a consistent, unified quantum theory predict the existence of new gravitational-strength forces, that among other things, will violate the principle. Such effects have been seen already in recent experiments. Hence, an experiment to measure the gravitational acceleration of antimatter could be of great importance to the understanding of quantum gravity. An international team has been formed to measure the graviational acceleration of antiprotons. Such an experiment would provide an unambiquous test, if new gravitational interactions do exist. 10 figs.

33714 **Elementary examples of adiabatic invariance.** Crawford, F.S. (Physics Department, University of California, Berkeley, CA (USA)—Lawrence Berkeley Laboratory, University of California, Berkeley, CA 94720 (USA)). *American Journal of Physics (USA),* 58(4): 337-344 (Apr 1990).

Simple classical one-dimensional systems subject to adiabatic (gradual) perturbations are examined. The first examples are well known: the adiabatic invariance of the product $E\tau$ of energy E and period τ for the simple pendulum and for the simple harmonic oscillator. Next, the adiabatic invariants of the vertical bouncer are found—a ball bouncing elastically from the floor of a rising elevator having slowly varying velocity and acceleration. These examples lead to consideration of adiabatic invariance for one-dimensional systems with potentials of the form $V=ax^n$, with $a=a(t)$ slowly varying in time. Then, the horizontal bouncer is considered—a mass sliding on a smooth floor, bouncing back and forth between two impenetrable walls, one of which is slowly moving. This example is generalized to a particle in a bound state of a general potential with one slowly moving "turning point." Finally, circular motion of a charged particle in a magnetic field slowly varying in time under three different configurations is considered: (a) a free particle in a uniform field; (b) a free particle in a nonuniform "betatron" field; and (c) a particle constrained to a circular orbit in a uniform field.

33715 **Covariant smoothed particle hydrodynamics on a curved background.** Kheyfets, A. (Spacetime Physics Group, High Energy Plasma Division, Weapons Laboratory, Kirtland Air Force Base, New Mexico 87117 (US)); Miller, W.A.; Zurek, W.H. *Physical Review, D (Particles Fields) (USA),* 41(2): 451-454 (15 Jan 1990).

We show that the smoothed-particle-hydrodynamics discretization technique is compatible with the principles of general relativity if the contact interactions are modeled by spatial smoothing functions in the local frame comoving with the fluid. We then develop a smoothed-particle-hydrodynamics algorithm to model a non-self-gravitating isentropic fluid on a curved background. The equations of the fluid are discretized using a kernel whose spatial support is of a constant proper width in the local comoving frame. The one-dimensional relativistic shock problem is used for testing this algorithm.

33716 **A simple Lagrangian for integrable systems.** de Almeida da Silva, M.A. (Instituto de Fisica, Universidade Federal do Rio de Janeiro, Rio de Janeiro, RJ 21945, Brazil (BR)); Das, A. *Journal of Mathematical Physics (New York) (USA),* 31(4): 798-800 (Apr 1990). DOE Contract AC02-76ER13065.

A simple Lagrangian for integrable models that can describe the entire hierachy of equations associated with the system is proposed. In addition, the Lax equation, the recursion relation between the conserved quantities, as well as the vanishing of the Nijenhuis torsion tensor can also be derived from the system of equations following from this Lagrangian.

33717 **Kinematic moment invariants for linear Hamiltonian systems.** Neri, F. (Center for Theoretical Physics, University of Maryland, College Park, Maryland 20742 (USA)); Rangarajan, G. *Physical Review Letters (USA),* 64(10): 1073-1075 (5 Mar 1990). DOE Contract AS05-80ER10666.

Quadratic moments of a particle distribution being transported through a linear Hamiltonian system are considered. A complete set of kinematic invariants made out of these moments are constructed leading to the discovery of new invariants.

33718 **Analytic solution of the two-state problem.** Carroll, C.E. (Department of Physics, Saint John Fisher College, Rochester, New York 14618 (USA)— Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627 (USA)); Hioe, F.T. *Physical Review, A (General Physics) (USA),* 41(5): 2835-2836 (1 Mar 1990). DOE Contract FG02-84ER13243.

An exact solution of the time-dependent Schroedinger equation is obtained for a simple model with only two quantum states. The calculated transition probability involves only exponential and hyperbolic functions.

33719 Perturbed period-doubling bifurcation. I. Theory. Svensmark, H. (Department of Physics, University of California, Berkeley, Berkeley, California 94720 (USA)— Materials and Chemical Sciences Division, Lawrence Berkeley Laboratory, Berkeley, California 94720 (USA)); Samuelsen, M.R. *Physical Review, B: Condensed Matter (USA),* 41(7): 4181-4188 (1 Mar 1990). DOE Contract AC03-76SF00098.

The influence of perturbations (a small, near-resonant signal and noise) on a driven dissipative dynamical system that is close to undergoing a period-doubling bifurcation is investigated. It is found that the system is very sensitive, and that periodic perturbations change its stability in a well-defined way that is a function of the amplitude and the frequency of the signal. New scaling laws between the amplitude of the signal and the detuning δ are found; these scaling laws apply to a variety of quantities, e.g., to the shift of the bifurcation point. It is also found that the stability and the amplification of the system are *not stationary*, but vary with δ. The results in this paper are found from a *linear* analysis of the dynamics in the Poincare map. It is thereby shown that several effects, which previously were believed to be caused by *nonlinearity* are in fact linear in the lowest order. Numerical and analog simulations of a microwave-driven Josephson junction confirm the theory. Results should be of interest in parametric-amplification studies.

70 FUSION ENERGY

33720 (DOE/ER/13595–T1) **Muonic molecular structure, μ-sticking probability and fusion rates for muon catalyzed fusion: Final technical report.** Hu, Chi-yu. California State Univ., Long Beach, CA (USA). Long Beach Foundation. 15 Apr 1990. 14p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract FG03-86ER13595. Order Number DE90010966. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the status of the ($dt\mu$), molecular structure and sticking probability, and the explicit inclusion of nuclear interaction using optical potentials and the reduced R-matrix.

33721 (HIFT–165) **Annual report, 1988. 4 - 1989. 3.** Hiroshima Univ. (Japan). Inst. for Fusion Theory. Apr 1989. 12p. (In Japanese). Order Number DE90791261. Available from NTIS (US Sales Only), PC A03/MF A01.

1988 was the tenth anniversary of the foundation of the Institute, and the commemoration book "Progress during 10 Years" was published. Also the tenth anniversary ceremony, lecture meeting and celebration party were held. Professor Ryogo KUBO of Keio University and Professor Kunioki MIMA gave lectures. The Institute begins in 1989 the transfer to the Nuclear Fusion Science Laboratory, which is the common utilization facilities of the Ministry of Education newly established in Toki City, Gifu Prefecture, and in 1990, it will be abolished. The research activities in the Institute continue to develop hereafter in the new Institute for Theory and Simulation. Also in 1988, the 12th international conference on plasma physics and controlled nuclear fusion research sponsored by IAEA was held in Nice, France, and three papers were presented from this Institute. The outline of the research activities on 26 themes is reported. (K.I.).

33722 (IPPCZ–293/II) **15th Czechoslovak seminar on plasma physics and technology. Part 2.** Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. 211p. (In English, Russian). (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

Of the 27 contributions contained in the second part of the Proceedings, 8 papers deal with the plasma arc spraying technology and with the diagnostics of sprayed coatings. Seven papers discuss various diagnostic methods used in experiments on plasma heating by relativistic electron beams (optical spectroscopy, diamagnetic and soft X-ray diagnostics). In 8 papers the experimental results on lower hybrid current drive in the Castor tokamak are described. The remaining 4 papers concern experiments on ion implosion on the SOWA facility, soft X-ray measurements in the gas-puff Z pinch, theoretical analysis of effects in a plasma with structured magnetic fields, and computer simulation of plasma dynamics in tokamak reactors. (J.U.).

33723 (ORNL/TM–11356) **Initial calorimetry experiments in the Physics Division, ORNL [Oak Ridge National Laboratory].** Hutchinson, D.P.; Bennett, C.A.; Richards, R.K.; Bullock, J.S. IV; Powell, G.L. Oak Ridge National Lab., TN (USA). May 1990. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90010301. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Four calorimetry experiments were performed with palladium cathode electrolysis cells to investigate the possibility of cold fusion heat production based on the reported results of Fleischmann and Pons. Two of the cells contained 6.35-mm-diam x 10-cm-long palladium cathodes in a 0.2-M ^{6}LiOD electrolyte; one cell contained a similar cathode in a 0.1-M ^{6}LiOD electrolyte solution; and one cell used a cast 1.27-cm-diam x 10-cm-long palladium rod in a 0.2-M electrolyte. All four cells were constructed with platinum wire anodes. One of the cells exhibited an apparent 2–3 W power excess for a period of approximately 300 hours of a total operating time of 1800 hours; each of the remaining cells remained in power balance for the 1800 hour period. 2 refs., 5 figs., 1 tab.

7001 Plasma Research

Refer also to citation(s) 32790, 32890, 32893, 32925, 32954, 33629, 33802, 33811, 33820, 33826, 33827, 33832

33724 (ANU-PRL-PP–89/6, pp. 3-5) **Configurational effects on plasma confinement in SHEILA.** Hamberger, S.M.; Blackwell, B.D.; Shi, X.H. Australian National Univ., Canberra (Australia). Plasma Research Lab. 1989. (CONF-890403–: 7. international workshop on stellarators, Oak Ridge, TN (USA), 10-14 Apr 1989). In *Papers presented at seventh international workshop on stellarators.* Order Number DE90625560. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Comparison between the measured plasma configurations and those computed from the coil currents show excellent agreement provided known field errors are taken into account. Low order resonances in a configuration have a strongly adverse affect on plasma confinement. Direct experimental evidence of island formation is seen when $\zeta \approx 3/2$. 6 figs.

33725 (ANU-PRL-PP–89/6, pp. 15-18) **ECH experiments in SHEILA.** Conway, G.D.; Blackwell, B.D. Australian National Univ., Canberra (Australia). Plasma Research Lab. 1989. (CONF-890403–: 7. international workshop on stellarators, Oak Ridge, TN (USA), 10-14 Apr 1989). In *Papers presented at seventh international workshop on stellarators.* Order Number DE90625560. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Preliminary experimental results of the first application of electron cyclotron heating power to plasmas confined in the heliac geometry are presented. Up to 2kW at 2.45 GHz has been employed and strong absorption at both the fundamental and second harmonic with either a helical or a shaped dipole antenna has been observed. Either peaked or broad radial density profiles were obtained, depending on the location of the resonant field layers. Breakdown at the second harmonic appears to require seeding by a fundamental produced plasma. Densities up to two orders of magnitude above O-mode cut-off are observed. 4 refs., 6 figs.

33726 (ANU-PRL-PP–89/6, pp. 28-32) **ICH system for Heliac H1.** Blackwell, B.D.; Conway, G.D. Australian National Univ., Canberra (Australia). Plasma Research Lab. 1989. (CONF-890403–: 7. international workshop on stellarators, Oak Ridge, TN (USA), 10-14 Apr 1989). In *Papers presented at seventh international workshop on stellarators.* Order Number DE90625560. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

An ion cyclotron heating system for the H-1 heliac has been defined. Stage 1 (1987-90) has concentrated on the construction and optimization of a fast wave (15 MHz - 180 kW) antenna system. Stage 2 of operation (1990-92) will investigate heating by ion Bernstein and whistler waves. 5 refs., 8 figs.

33727 (ANU-PRL-PP–89/6, pp. 11-14) **Electron beam measurements in SHEILA using a simple method of image intensification.** Blackwell, B.D.; Tou, T.Y. Australian National Univ., Canberra (Australia). Plasma Research Lab. 1989. (CONF-890403–: 7. international workshop on stellarators, Oak Ridge, TN (USA), 10-14 Apr 1989). In *Papers presented at seventh international workshop on stellarators.* Order Number DE90625560. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A simple, cost-effective image-intensifying fluorescent probe and subminiature two-element electron gun have been developed and used in the heliac SHEILA to map its magnetic surfaces. A 128 x 128 pixel CCD camera records the visible image which is accumulated digitally as the fluorescent rod is moved through the magnetic surface. Image-intensification allows the use of a low velocity beam, minimizing drift errors. The gain characteristic and resolution of the intensifier are examined, and result for typical closed and open magnetic surfaces are given. 5 figs.

33728 (ANU-PRL-PP–89/6, pp. 23-27) **A diagnostic for 2D density profiles in Heliac H-1.** Howard, J.; Sharp, L.E. Australian National Univ., Canberra (Australia). Plasma Research Lab. 1989. (CONF-890403–: 7. international workshop on stellarators, Oak Ridge, TN (USA), 10-14 Apr 1989). In *Papers presented at seventh international workshop on stellarators.* Order Number DE90625560. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A novel multi-view scanning interferometer is described. An air turbine driven scanning rotating grating wheel is used to produce ≈ 30 distinct spatial channels in four equi-spaced views of the H-1 plasma. The interferometer signals, derived from just three detectors, are multiplexed in time with a resolution of ≈ 1 ms. 7 refs., 3 figs.

33729 (ANU-PRL-PP–89/6, pp. 6-10) **Experimental studies on drift waves in SHEILA.** Blackwell, B.D.; Hamberger, S.M.; Shi, X.H. Australian National Univ., Canberra (Australia). Plasma Research Lab. 1989. (CONF-890403–: 7. international workshop on stellarators, Oak Ridge, TN (USA), 10-14 Apr 1989). In *Papers presented at seventh international workshop on stellarators.* Order Number DE90625560. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Detailed studies of coherent fluctuations in several configurations of SHEILA support the view that these are essentially electrostatic collisional drift waves propagating so that the ratio of toroidal to poloidal mode numbers closely matches the rotational transform. The observations are consistent with a linear dispersion theory based on a cylindrical approximation to the helical plasma column in straight-field coordinates. 10 figs.

33730 (ANU-PRL-PP–89/8) **A novel scanning interferometer for two-dimensional plasma density measurements.** Howard, J. Australian National Univ., Canberra (Australia). Plasma Research Lab. 1989. 19p. Order Number DE90625514. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A novel multichannel scanning interferometer designed for tomographically inferring contours of electron density in magnetically confined plasmas is described. The scanning element is a multi-sectored blazed rotating grating. The diffracted beam emerges at a different angle from each sector giving rise to a fan array of discrete beams for each rotation of the grating. Signals from the probing chords are multiplexed in time enabling the use of a single detecting element for the extraction of many channels of line integrated density information. An air turbine driven grating wheel assembly has been fabricated and initial tests performed. The proposed interferometer is to be installed on the H-1 helical axis stellarator currently under construction at the Australian National University. 16 refs., 12 figs.

33731 (CONF-8909331–1) **Electromagnetic computations for fusion devices.** Turner, L.R. Argonne National Lab., IL (USA). Sep 1989. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From COMPUMAG Tokyo conference; Tokyo (Japan); 3-7 Sep 1989. Order Number DE90011097. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Among the difficulties in making nuclear fusion a useful energy source, two important ones are producing the magnetic fields needed to drive and confine the plasma, and controlling the eddy currents induced in electrically conducting components by changing fields. All over the world, researchers are developing electromagnetic codes and employing them to compute electromagnetic effects. Ferromagnetic components of a fusion reactor introduce field distortions. Eddy currents are induced in the vacuum vessel, blanket and other torus components of a tokamak when the plasma current disrupts. These eddy currents lead to large forces, and 3-D codes are being developed to study the currents and forces. 35 refs., 6 figs.

33732 (DOE/ER/52147–3) **Microwave generation for magnetic fusion energy applications, Task A: Progress report, September 15, 1989–September 14, 1990.** Antonsen, T.M. Jr.; Destler, W.W.; Granatstein, V.L.; Levush, B.; Mayergoyz, I.D.; Singh, A. Maryland Univ., College Park, MD (USA). May 1990. 55p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER52147. Order Number DE90011042. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

This report details progress over the past year in the research program "Free Electron Lasers with Short Period Wigglers." The work is performed jointly by the laboratory for Plasma Research and the Electrical Engineering Department of the University of Maryland and is funded by the US Department of Energy Office of Fusion Energy. The goal of the work is the development of an electron cyclotron resonance heating (ECRH) scheme for magnetic fusion plasmas such as the Compact Ignition Tokamak (CIT). Our approach is the development of a free electron laser using a sheet electron beam and a short period wiggler magnet. The specific requirements for the heating method include 10 to 30 MW of average power with pulse durations of several seconds to CW at a frequency near 300 GHz (~600 GHz) in the case of second harmonic (ECRH). Compatible with the experimental nature of the program, radiation frequency flexibility of 30% total bandwidth and 5% rapid dynamic (≲10 ms) bandwidth is desirable. As the source will eventually be applied to a reactor, priority is placed upon high system efficiency and reliability. Use of established technologies is encouraged where possible.

33733 (DOE/ER/53222–102) **Transport simulation of the effect of impurity radiation on the high beta, ohmic start-up of the HBT-EP tokamak.** Vijaya Sankar, M.K.; Mauel, M.E. Columbia Univ., New York, NY (USA). Dept. of Applied Physics. 1990. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER53222. Order Number DE90010333. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This research report gives the effect of impurity radiation on the attainment of high beta and high temperature for an ohmic discharge in the case of a tokamak like HBT-EP. Time dependent, one dimensional transport calculations were done using the HERMES code. The permissible impurity influx from the wall was found to decrease with increase in the magnetic field. For attaining a plasma temperature around 100 eV with the value of β close to the Troyon β limit, the maximum magnetic field was found to be around 0.6 Tesla with a maximum permissible impurity influx of about 0.2% of the hydrogen ion flux reaching the wall. 7 refs., 8 figs.

33734 (DOE/ER/53236–T2) **Technical progress report for ICRF [Ion Cyclotron Range of Frequencies] edge modeling.** Grumman Aerospace Corp., Princeton, NJ (USA). Corporate Research Center. 10 Jan 1990. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER53236. Order Number DE90011432. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report describes the technical progress covering the period from May 15, 1989 to the present for the DOE sponsored grant, "ICRF Edge Modeling." Progress in the areas of antenna design, and kinetic modeling of ions and electrons is cited. The design of antennas for CIT and C-MOD is currently an ongoing activity. Ion kinetic modeling indicates the impurity ion heating is not an important impurity production mechanism. The development of a quasilinear model for electron heating is presented. The relevant professional activities sponsored by this grant are given.

33735 (DOE/ER/53266–32) **Plasma confinement theory and transport simulation: Technical progress report, November 1,**

1989–October 31, 1990. Ross, D.W. Texas Univ., Austin, TX (USA). Fusion Research Center. Apr 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER53266. Order Number DE90011072. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The objectives of this page are to advance the transport studies of tokamaks, including development and maintenance of the Magnetic Fusion Energy Database, and to provide theoretical interpretation and modelling for TEXT, and equilibrium and stability studies for TEXT-Upgrade.

33736 (DOE/ER/53295–1) **A portable and independent edge fluctuation diagnostic: Technical progress report, September 14, 1989–May 14, 1990.** Ritz, C.P.; Wootton, A.J. Texas Univ., Austin, TX (USA). Fusion Research Center. [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-89ER53295. Order Number DE90011442. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

During the early phase of the project (October–December 1989) we have built a portable probe drive and control electronics. The electronics and workstation (Mac IIci) have been purchased. During this initial phase we have conducted experiments at the ATF stellarator of the Oak Ridge National Laboratory and (from mid January to mid February 1990) at the ZT-40M reversed field pinch (RFP) of the Los Alamos National Laboratory. On both devices we used the reciprocating probe drive and probe arrays developed on TEXT for a simultaneous measurement of density, electron temperature, floating potential and their fluctuation quantities. This report discusses these results.

33737 (DOE/ET/53088–432) **Fluctuation and thermal energy balance for drift-wave turbulence.** Kim, Chang-Bae (Texas Univ., Austin, TX (USA). Inst. for Fusion Studies); Horton, W.; Hong, Bong-Guen. Texas Univ., Austin, TX (USA). Inst. for Fusion Studies. May 1990. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-80ET53088. (IFSR–432). Order Number DE90011054. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Energy conservation for the drift-wave system is shown to be separated into the wave-energy power balance equation and an ambient thermal-energy transport equation containing the anomalous transport fluxes produced by the fluctuations. The wave energy equation relates the wave energy density and wave energy flux to the anomalous transport flux and the dissipation of the fluctuations. The thermal balance equation determines the evolution of the temperature profiles from the divergence of the anomalous heat flux, the collisional heating and cooling mechanisms and the toroidal pumping effect. 16 refs., 1 tab.

33738 (HIFT–167) **Simulation study of self-organization and self-relaxation processes in plasma.** Horiuchi, Ritoku (Science Project Corp., Hiroshima (Japan)); Kusano, Kanya; Watanabe, Kunihiko; Hayashi, Takaya; Sato, Tetsuya; Nishikawa, Kyoji. Hiroshima Univ. (Japan). Inst. for Fusion Theory. Sep 1989. 24p. Order Number DE90791262. Available from NTIS (US Sales Only), PC A03/MF A01.

The second law of thermodynamics appears to imply that all structures constantly decay to reduce the entire universe eventually to a state of complete randomness. In reality, however, a wide variety of structures do exist and continue to develop, as can be seen clearly in the biological system. Such spontaneous generation and maintenance of structures is called self-organization. Recent progress in plasma physics has revealed that a plasma exhibits many such processes. Since instabilities and resistive diffusions will disturb or modify the magnetic field configuration, one usually has to introduce an extremely complicated external control of the plasma in order to keep an appropriate magnetic configuration. If there exists an intrinsic physical mechanism to form and sustain such a magnetic configuration, then one can sustain the high-temperature plasma simply by supplying some global physical quantities to the system. Numerical simulations reveal much of the dynamics for self-organization along with the mechanism of selective dissipation. The essential processes for self-organization in a plasma are the nonlinear development of ideal magnetohydrodynamic instabilities and magnetic reconnection driven by it. During these processes, plasma selects the most effective path for the energy relaxation and realizes the minimum energy state. (N.K.).

33739 (IC–89/150) **Electron acoustic and magnetoacoustic modes in a magnetized beam plasma system.** Jain, V.K.; Tsintsadze, N.L. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 5p. Order Number DE90627473. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The dispersion relation characterizing electrostatic modes in a cold magnetized plasma penetrated by a hot electron beam is solved analytically. In the limit $k^2 \lambda_b^2 << 1$, where k is the wavenumber of the mode and λ_b is the Debye length of beam electrons, two new modes viz. electron acoustic and electron magneto-acoustic, are found to exist. Expressions for the growth rate and threshold beam energy are obtained for the kinetic instabilities of these modes. (author). 10 refs.

33740 (IC–89/405) **Measurement of gravitational acceleration of antimatter.** Rouhani, S. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 10p. Order Number DE90627464. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The minute yet effective impact of gravitational potential in the central region of a long tube magnetic container of non-neutral plasmas can be utilized for the measurement of the gravitational acceleration of antimatter particles. The slight change in distribution of plasma particles along the gravitational field affects the internal electric field of the plasma, which in turn affects the frequency of the magnetron motion of its particles. Thus, a rather straightforward relation is established between the gravitational acceleration of the particles and their magnetron frequencies, which is measurable directly, determining the value of the gravitational acceleration. (author). 7 refs, 3 figs.

33741 (IPP–6/287) **Is the temperature gradient or the derivative of the density gradient responsible for drift solitons?.** Salat, A. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Jan 1990. 19p. Order Number DE90792234. Available from NTIS (US Sales Only), PC A03/MF A01.

In conventional drift wave theory the density gradient $\kappa_n = d \ln n / d\chi$ determines the linear phase velocity, and the (electron) temperature gradient $\kappa_T = d \ln T / d\chi$ gives rise to a nonlinear term which leads to the existence of soliton-type solutions and solitary waves. LAKHIN, MIKHAILOVSKI and ONISHCHENKO, Phys. Lett. A 119, 348 (1987) and Plasma Phys. and Contr. Fus. 30, 457 (1988), recently claimed that it is not κ_T but essentially the derivative of the density gradient, $d\kappa_n/d\chi$, that is relevant. This claim is refuted by means of an expansion scheme in $\epsilon = e\Phi/T \leq 1$, where Φ is the drift wave potential. (orig.)

33742 (IPPCZ–293/II, pp. 16-23) **Non-stationary computer model of the asymptotic region of an electric arc gas heater.** Jenista, J. (Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu). Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

An electric arc gas heater with an axial gas supply is studied theoretically. The basic set of MHD equations is reduced to a single non-stationary energy balance equation, which is solved numerically. The electric field strength is calculated in dependence on the total discharge current and on the gas temperature, together with the radial profiles of the current density and of the temperature. The physical results obtained for nitrogen are compared with experimental ones. The method described makes it possible to distinguish between stable and unstable stationary solutions and to examine in detail the transient phenomena occurring during formation of the stationary state. (J.U.). 9 figs., 3 refs.

33743 (IPPCZ–293/II, pp. 67-74) **Some results of diamagnetic measurements on Rebex machine.** Ullschmied, J. (Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu). Ceskoslovenska Akademie Ved, Prague

(Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

The interpretation is discussed of oscillating diamagnetic signals observed in experiments with plasma heating by high-current relativistic electron beams. Using a simplified macroscopic model of hot plasma column dynamics, the local plasma energy content, the plasma density and the rate of energy losses can be calculated from the diamagnetic data. The time-and-space maps of magnetic fields, constructed from signals of several diamagnetic probes, were employed to determine also the time dependence of the total plasma energy and of its longitudinal distribution. (J.U.). 6 figs., 9 refs.

33744 (IPPCZ–293/II, pp. 75-78) **Model of collisional and radiative processes in REBEX plasma.** Raus, J. (Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu); Babicky, V. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

The non-stationary corona model is used for calculations of time-dependent radiation spectra of a hydrogen plasma with a small amount of oxygen impurity, heated by a pulsed high-current relativistic electron beam. Two series of calculations were made - with a constant (step-like) temperature and with a more realistic time-dependent temperature. It is shown that under the REBEX conditions the radiation losses represent the dominant loss mechanism. Using computed spectra, the theoretical signal of the X-ray diode used for X-radiation measurements in the REBEX facility was calculated and compared with the experiment. (J.U.). 8 figs., 5 refs.

33745 (IPPCZ–293/II, pp. 79-86) **Time development of profile of H_α line in REBEX plasma.** Ripa, M. (Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu); Kolacek, K.; Ullschmied, J. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

The broadening of the H_α line during and after the injection of a high-current relativistic electron beam into a hydrogen plasma was studied experimentally on the REBEX machine. For an analysis of the line profile, a six-channel polychromator with a spectral resolution of 0.084 nm per channel was used. The output signals were digitized with a time step of 4 ns and processed by a computer. The investigated line broadens substantially during the beam injection but its profile remains Gaussian with high precision. After beam injection the line profile shows periodical variations correlated with radial oscillations of the heated plasma column. The maximum line width corresponds to hydrogen temperatures of some 30 eV. No Stark broadening due to turbulent HF fields was recognized against the high Dopler background. (J.U.). 6 figs., 3 refs.

33746 (IPPCZ–293/II, pp. 87-91) **Apparatus for measurement of spectral line profile.** Ripa, M. (Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu); Kolacek, K.; Clupek, M. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

The apparatus used for measurements of Balmer line profiles at the REBEX experiment is described in detail. The illuminating optical system transmits light from a plasma to the spectroscopic part of the instrument. The spectral analysis is performed by a six-channel polychromator based on mirror monochromator SPM-2 with a plane grating. The key part of the detection system is a light pipe head supplied with six optical strip lines coupled to photomultipliers. The evaluating part consists of fast digitizers and a computer-controlled data processing system. The spectral and time resolution of the apparatus is 0.084 nm per channel and 10 ns, respectively. (J.U.). 3 figs., 3 refs.

33747 (IPPCZ–293/II, pp. 92-95) **Time resolved diagnostics of hot plasma radiation by Si surface barrier detectors.** Piffl, V. (Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu); Clupek, M. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

The energy distribution of electrons in a plasma heated by a high-current relativistic electron beam was studied experimentally using X-ray plasma diagnostics. Plasma X radiation in the energy range from 100 eV to 10 keV was detected with a special four-channel silicon surface barrier detector and the spectrum was roughly analyzed using a set of foil filters. A high-energy component was found in the bremsstrahlung from a carbon target placed in the plasma periphery. The best fit for the experimental data was obtained with the electron distribution function inversely proportional to the electron energy. The energy contained in the observed part of the energy spectrum is some 10 per cent of the injected beam energy. The high-energy electrons live a surprisingly long time after the beam injection. (J.U.).

33748 (IPPCZ–293/II, pp. 96-101) **The potential of CCDs for hot plasma diagnostics.** Pina, L. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska). Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

The TESLA TS 110 linear CCD array was used to demonstrate the usefulness of CCD (charge-coupled device) elements for detection and imaging of plasma radiation from the infrared to the soft X-ray region. The calculated optical and X-ray sensitivities proved to be well suitable especially for applications in hot plasma diagnostics. Computer controlled electronics and a software packet for data acquisition and handling were developed and the whole system was tested in a series of experiments with laser-produced plasma. (J.U.). 4 figs., 5 refs.

33749 (IPPCZ–293/II, pp. 105-109) **K-lines in soft X-ray spectrum and the determination of plasma parameters of Ar Z-pinch.** Krejci, A. (Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu); Krousky, E.; Pfeifer, M.; Renner, O. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

Soft X radiation emitted from hot spots in a gas-puff Z pinch in argon was investigated. For measurements of the size of the hot spots and for rough spectral analysis of the radiation, several pinhole cameras provided with mylar foils of various thickness were used. The fine structure of the spectrum was resolved by means of a flat silicon crystal spectrometer. The electron temperature was computed from the ratios of the He-like resonance line and its dielectronic satellites, using a slightly modified corona model. The electron density was calculated from relative intensities of the resonance and intercombination lines according to the collisional-radiative model. The smallest hot spot size recognized was 30 μm, the electron temperature and density reaching 1.1 keV and 4.10^{27} m^{-3}, respectively. (J.U.). 3 figs., 7 refs.

33750 (IPPCZ–293/II, pp. 153-156) **Control of plasma position on the Castor tokamak.** Valovic, M. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

A simple servo-system used at the Castor tokamak for the control of radial plasma position is described. This feedback system is capable of maintaining the plasma ring in a prescribed position with an accuracy of 3 mm. The performance of the system is demonstrated by comparing the parameters of tokamak discharges with and without the feedback control. (J.U.). 2 figs.

33751 (IPPCZ–293/II, pp. 157-163) **Electrostatic edge turbulence on CASTOR tokamak.** Stoeckel, J. (Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu); Kryska, L.; Jakubka, K.; Zacek, F.; Weixelbaum, L.; Wenzel, U.; Nanobashvili, S. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

The electrostatic edge turbulence in the Castor tokamak was studied by a movable triple Langmuir probe connected with a three-channel analog correlator. Two channels operated in the autocorrelation mode and served for monitoring the RMS values of fluctuations of the density and poloidal electric field. The third channel operated in the cross-correlation mode and monitored directly the radial turbulent flux. In the combined inductive and lower hybrid current drive tokamak regimes, the electrostatic edge turbulence decreased substantially. This suppression of turbulence is apparently a dominant mechanism for the observed improvement of particle confinement. (J.U.). 3 figs., 8 refs.

33752 (IPPCZ–293/II, pp. 174-191) **A model for the electrostatic turbulence observed in the Castor tokamak.** Vlad, M. (Central Inst. of Physics, Bucharest (Romania)); Spineanu, F.; Badalec, J.; Stoeckel, H.; Zacek, F. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

Studies of the anomalous transport in the Castor tokamak are based on measurements of plasma turbulence and on computer simulations of plasma evolution. The inverse transport problem is solved, e.g., the transport coefficients are determined from the measured plasma parameters. Starting from the empirically obtained anomalous thermal conductivity coefficient, a theoretical analysis of the microinstabilities underlying this anomalous transport is presented and an explanation of the microscopic turbulence onset and evolutionis proposed. The calculated time evolutions of radial profiles of the main plasma parameters are shown. (J.U.). 9 figs., 10 refs.

33753 (IPPCZ–293/II, pp. 192-193) **Particle injection into the Castor tokamak by electric arcs.** Hildebrandt, D. (Akademie der Wissenschaften der DDR, Berlin (German Democratic Republic). Zentralinstitut fuer Elektronenphysik); Juettner, B.; Pursch, H.; Jakubka, K.; Stoeckel, J.; Zacek, F. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

The influence of arcing on the tokamak discharge was investigated in the Castor tokamak. A special calibrated gun which emitted tantalum by artificially ignited electric arcs, was used to study the transport of the injected tantalum ions, neutrals and droplets. The injection of tantalum led to an increase in electron density and to a change of plasma position only if the transported charge was higher than 0.01 C. As the naturally occurring arcs are well below this limit, the arcing in tokamaks is rather the consequence than the reason of instabilities. (J.U.).

33754 (IPPCZ–293/II, pp. 194-203) **Computer simulation of the interaction of LH waves with thermonuclear alpha particles.** Pavlo, P.; Krilin, L.; Tluchor, Z. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

The results are presented of a computer simulation of the damping of lower hybrid waves on alpha particles in a tokamak reactor. The two-dimensional Fokker-Planck equation completed with a quasilinear term was solved for ITER parameters. The first-orbit and loss-cone losses were accounted for via boundary conditions. Non-negligible absorption, accompanied by acceleration of a group of particles to energies higher than twice the born energy, was obtained for frequencies below 4.5 GHz. (J.U.). 2 figs., 10 refs.

33755 (IPPCZ–293/II, pp. 148-152) **Tokamak radiation measurements by microchannel plate detector.** Kalvin, S. (Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics); Bakos, J.S.; Buerger, G.; Kardon, B.; Petravich, G.; Veres, G.; Zoletnik, S. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

VUV and soft X radiation measurements were performed on the MT-1 and CASTOR tokamaks using a microchannel-plate detector. This technique made it possible to detect radiation along twelve chords simultaneously. The radiation was roughly analyzed by means of various foil filters. A series of measurements was made to investigate the time evolution of radial radiation profiles in various energy bands. During plasma disruptions, enhanced low-energy radiation has been found in the whole plasma cross section. (J.U.). 5 figs., 5 refs.

33756 (IPPCZ–293/II, pp. 164-173) **Edge density profile studies in the Castor tokamak using a thermal lithium beam.** Weixelbaum, L. (Akademie der Wissenschaften der DDR, Berlin (German Democratic Republic). Zentralinstitut fuer Elektronenphysik); Wenzel, U.; Hayess, E.; Badalec, J.; Jakubka, K.; Kryska, L.; Stoeckel, J.; Valovic, M.; Zacek, F. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

The electron density profiles of the Castor tokamak plasma were determined from measured visible light emission of lithium atoms injected radially into the tokamak and excited by electron collisions. The probing beam of thermal lithium atoms was produced by a thermal lithium source. The lithium emission line was selected by an interference filter and imaged on a CCD (coupled-charge devices) line. Investigation of the poloidal symmetry confirmed a marked difference between the profiles measured at the top and at the bottom of the torus. In lower hybrid current drive regimes, steeper radial profiles were found both at the top and at the bottom, in correlation with the improved particle confinement witnessed by other diagnostic methods. (J.U.). 4 figs., 3 refs.

33757 (IPPCZ–293/II, pp. 142-147) **Modelling the edge plasma dynamics in a tokamak using Grad's approximation.** Rabinski, M. (Institute for Nuclear Studies, Otwock-Swierk (Poland)). Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (In Russian). (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th*

Czechoslovak seminar on plasma physics and technology. Part 2. Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

A mathematical model is set up which makes possible to study various transport processes in the edge plasma in tokamaks. The two-fluid hydrodynamic description is used with the non-local transport coefficients determined in a thirteen-moment Grad's approximation. Alternative models of neutral gas dynamics, e.g., that in a poloidal divertor are presented. The model was incorporated in software packet EDGE1D, exploited for one-dimensional modelling of the edge plasma and neutral gas in tokamaks. (J.U.). 4 refs.

33758 (IPPCZ–293/II, pp. 117-141) **Nonlinear effects in a plasma with structured magnetic fields.** Ryutova, M.P. (AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki). Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

Magnetic fields of filamentary structure are often met both in space and laboratory plasmas. Such magnetic fields play a dominant role in all the active processes in the solar atmosphere. The properties of separation magnetic flux tubes and their assemblies are studied theoretically. The linear oscillations of a single flux tube are classified and the damping mechanisms of long-wave oscillations are described. The effect of sheared flows, the appearance of negative energy waves and their nonlinear explosive instabilities, and the generation of non-oscillatory secondary "magnetosonic" flows are also discussed. (J.U.). 6 figs., 12 refs.

33759 (IPPCZ–293/II, pp. 204-207) **On the application of the nonlinear reflection coefficient theory to some lower hybrid experimental results on PLT tokamak.** Petrzilka, V.A.; Pavlo, P. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

The nonlinear theory of wave-plasma interaction is used to explain the dependence of the wave reflection coefficient on the input power, which was observed during lower hybrid experiments in the PLT tokamak. The reflection coefficients of all the four PLT grills used were calculated for a power density ranging from zero to 10 kW/cm^2 and for two extreme values of the edge plasma density parameter. The theoretical results agree, at least qualitatively, with the experimental observations. (J.U.). 4 figs., 2 refs.

33760 (IPP–III/152) **An optical scanning system for spectroscopic impurity flux investigations inside the ASDEX tokamak.** Fussmann, G. (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)); Hofmann, J.V.; Janeschitz, G.; Szigeti, J. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Oct 1989. 37p. Order Number DE90792226. Available from NTIS (US Sales Only), PC A03/MF A01.

A scanning mirror system was developed to resolve impurity flux sources spatially across about 2/3 of the ASDEX surface by using visible spectroscopy. A totally computer-controlled layout allows wide-range spatial scanning during a discharge. Spectra over a range of α 150 A are recorded with an integration time down to 20 ms. The versatility of this new system is illustrated by means of first observations of ASDEX discharges with additional heating (NI, LH, ICRH) and modulated gas puffing experiments. (orig.).

33761 (IPP–III/155) **Production of a short hydrogen gas pulse by laser-induced desorption from titanium hydride for investigation of transport processes in fusion plasmas.** Fischer, R. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Jan 1990. 86p. (In German). Order Number DE90792232. Available from NTIS (US Sales Only), PC A05/MF A01.

The investigation of particle transport in fusion plasmas requires short intense gas pulse to produce spatially and temporally localised density perturbations. Such gas pulses can be produced by laser induced desorption of hydrogen from titanium hydride. To study the properties of this method samples of $TiH_{1.5}$ have been heated by 1 ms ruby laser with an energy content up to 10 J. With target spot diameters of 4.5 mm desorption rates of $2x10^{18}$ hydrogen atoms have been achieved. The duration of the gas puffs is closely coupled to the laser pulse. Computer simulations have shown that the desorption rate is probably reduced by surface effects. When heating the same target spot repeatedly the release of hydrogen is reduced drastically. This due to the depletion of the 100 μm thick heated region at the target surface which cannot be refilled by hydrogen from the bulk because of the low diffusion coefficient of hydrogen in titanium at temperatures below 200deg C. For practical applications it therefore seems to be necessary to change the target spot after each shot. With respect to radiation cooling of the plasma the titanium content of the hydrogen pulses is important. In our experiments we found a 1per mille contamination with titanium atoms mainly produced by evaporation from edges of cracks in the target surface. Such cracks inevitably occur during the target preparation. By proper conditioning of the target surface with short giant laser pulses the titanium contamination could be reduced by a factor of two without reduction of the hydrogen release. The results of our measurements show that with a 40 J laser system gas pulses suitable for transport studies can be produced. (orig.).

33762 (IPP–III/156) **Measurement of the Lyman-alpha radiation at ionization manometers for determination of the hydrogen atom number density in fusion experiments.** Loercher, M. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Jan 1990. 68p. (In German). Order Number DE90792230. Available from NTIS (US Sales Only), PC A04/MF A01.

Codes like DEGAS which simulate the interaction of neutral gas with plasma (e.g. in a divertor), not only deliver the global density and flux of neutral particles, but also allow one, in addition, to distinguish between atoms and molecules. Whereas the global parameters of the neutral gas in a divertor can be measured by, for example, special ion gauges like those, which are installed in the divertor chamber, there has until now been no possibility of measuring the atomic and molecular density independently. In the frame of a diploma thesis (M. Loercher) an ASDEX neutral pressure gauge was modified in such a way that it delivers not only the global density of neutral particles (molecules and atoms) by ionization, but also the density of the atoms by measurement of the Lα-radiation produced by electron impact exitation. Owing to the very weak intensity the main effort was dedicated to developing a detector-filter combination which allows the Lα-radiation to be separated from, the H_2 bands in the VUV and be measured with a time resolution of at least of few ms. Several versions were tested theoretically and practically. The best solution was found to be a combination of an O_2 filter using MgF_2 windows and a multichannel plate. The arrangement was tested and calibrated with an atomic beam of known intensity from an oven. (orig.).

33763 (JAERI-M–89-133) **A study on the heating and diagnostic of a tokamak plasma by electromagnetic waves of the electron cyclotron range of frequencies.** Hoshino, Katsumichi (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research EstablishmentJP). Japan Atomic Energy Research Inst., Tokyo (Japan). Sep 1989. 356p. (In Japanese). Order Number DE90791312. Available from NTIS (US Sales Only), PC A16/MF A01.

A study on the heating and diagnosis of tokamak plasma by electromagnetic waves of electron cyclotron range of frequency is summarized. The main results obtained are as follows. On the engineering and technology, the technology of injecting high frequency, large power millimeter waves into tokamak plasma was established by carrying out the design, manufacture and test of a 60 GHz, 400 kW high frequency heating system, and the design, manufacture and test of a heterodyne type electron cyclotron radiation multi-channel mealsuring system were carried out, and the technology of measuring the radiation from tokamak plasma with the time resolution of 10 μs in multi-channel was established. On nuclear fusion reactor core engineering and plasma physics, the high efficiency electron heating of tokamak plasma by the incidence of fundamental irregular and regular waves at electron cyclotron frequency was verified. The discovery and analysis of the

heating by electrostatic waves arising due to mode transformation from electromagnetic waves in upper hybrid resonance layer were carried out. By the incidence of second harmonic waves, the high efficiency electron heating of tokamak plasma was verified, and the heating characteristics were clarified. And others. (K.I.) 179 refs.

33764 (JET-R–(89)16) **JET contributions to the workshop on the new phase for JET: the pumped divertor proposal.** Commission of the European Communities, Abingdon (UK). JET Joint Undertaking. Sep 1989. 196p. (CONF-8909326–: Workshop on the new phase for JET: the pumped divertor proposal, Culham (UK), 25-26 Sep 1989). Order Number DE90625445. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

Contributions to the Workshop consist of 13 papers on the new phase of operation of JET, including an outline of the objectives of the study of impurity control and the operating domain relative to the next generation of tokamaks. Studies are presented on the pumped divertor proposed for JET, diagnostic measurements required, and the performance expectations in the new configuration. (U.K.).

33765 (JET-R–(89)16, pp. 1-19) **The new phase for JET and its objective.** Rebut, P.-H. (Commission of the European Communities, Abingdon (UK). JET Joint Undertaking); Lallia, P.P. Commission of the European Communities, Abingdon (UK). JET Joint Undertaking. Sep 1989. (CONF-8909326–: Workshop on the new phase for JET: the pumped divertor proposal, Culham (UK), 25-26 Sep 1989). In *JET contributions to the workshop on the new phase for JET: the pumped divertor proposal: Workshop held at JET on 25/26 September 1989.* Order Number DE90625445. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The pumped divertor proposal would add a new phase to the JET programme dedicated to the studies of impurity control and operating domain for the next generation of Tokamaks. It would aim at focussing operations along the geometry considered for the next step and make the best use of the existing investment on JET in expertise and equipment for the preparation of NET, and later, DEMO. (U.K.).

33766 (JET-R–(89)16, pp. 20-40) **Modelling the pumped divertor.** Watkins, M.L. (Commission of the European Communities, Abingdon (UK). JET Joint Undertaking); Simonini, R.; Taroni, A.; Harbour, P.J.; Keilhacker, M.; Rebut, P.-H. Commission of the European Communities, Abingdon (UK). JET Joint Undertaking. Sep 1989. (CONF-8909326–: Workshop on the new phase for JET: the pumped divertor proposal, Culham (UK), 25-26 Sep 1989). In *JET contributions to the workshop on the new phase for JET: the pumped divertor proposal: Workshop held at JET on 25/26 September 1989.* Order Number DE90625445. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The aim of the axisymmetric pumped divertor proposed for the New Phase of JET has two aspects: firstly, to control the back-flow of impurities from the target plates towards the main plasma; and secondly, to limit the heat load on the target plates and, hence, their erosion. To achieve this aim it is proposed: firstly, to entrench the impurities in a forced flow of plasma directed along the open magnetic field lines in the scrape-off-layer towards the target plates; and secondly, to reduce the plasma temperature at the target plates by radiating a substantial fraction of the power flow in the vicinity of the target plates. Modelling studies of impurity control and radiation in the JET pumped divertor configuration are reported. (author).

33767 (JET-R–(89)16, pp. 41-62) **Experimental evidence from present X-point operation in JET.** Harbour, P.J. (Commission of the European Communities, Abingdon (UK). JET Joint Undertaking). Commission of the European Communities, Abingdon (UK). JET Joint Undertaking. Sep 1989. (CONF-8909326–: Workshop on the new phase for JET: the pumped divertor proposal, Culham (UK), 25-26 Sep 1989). In *JET contributions to the workshop on the new phase for JET: the pumped divertor proposal: Workshop held at JET on 25/26 September 1989.* Order Number DE90625445. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The scrape-off-layer in present X-point discharges in JET has been operated over a wide range of parameters and although they do not overlap those of the proposed pumped divertor, they go some way towards demonstrating that the parameters of the pumped divertor are feasible. (author).

33768 (JET-R–(89)16, pp. 63-70) **The overall configuration.** Huguet, M. (Commission of the European Communities, Abingdon (UK). JET Joint Undertaking). Commission of the European Communities, Abingdon (UK). JET Joint Undertaking. Sep 1989. (CONF-8909326–: Workshop on the new phase for JET: the pumped divertor proposal, Culham (UK), 25-26 Sep 1989). In *JET contributions to the workshop on the new phase for JET: the pumped divertor proposal: Workshop held at JET on 25/26 September 1989.* Order Number DE90625445. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The key concept of the proposed JET pumped divertor is that since sputtering of impurities cannot be suppressed at the target plate of a divertor, those impurities should be confined in the vicinity of the target plate itself. This confinement can be achieved by maintaining a strong directed flow of plasma particles along the divertor channel towards the target plates so as to prevent the back diffusion of impurities by the action of a frictional force. A most important feature of the configuration is the connection length, along the magnetic field lines, between the X-point region and the target plates. This distance should be long (of the order of 10 metres) in order to achieve an effective screening effect of the impurities. In other words, the X-point should be well separated from the target plates and this can only be achieved by a coil which is internal to the vessel. The proposed configuration consists of a single additional poloidal field coil, inside the vessel, at the bottom. (author).

33769 (JET-R–(89)16, pp. 71-99) **Equilibrium configuration for a high current pumped divertor.** Lazzaro, E. (Commission of the European Communities, Abingdon (UK). JET Joint Undertaking); Keegan, B. Commission of the European Communities, Abingdon (UK). JET Joint Undertaking. Sep 1989. (CONF-8909326–: Workshop on the new phase for JET: the pumped divertor proposal, Culham (UK), 25-26 Sep 1989). In *JET contributions to the workshop on the new phase for JET: the pumped divertor proposal: Workshop held at JET on 25/26 September 1989.* Order Number DE90625445. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

A realistic design of a pumped divertor plasma configuration to be fitted to the JET vessel can be obtained as a compromise among various geometrical, physical and technical constraints. The possibility of reaching a satisfactory solution has been analysed for plasmas up to 6 MA. Optimisation of the plasma coupling to the RF antennae requires a largely asymmetric distribution of ampere turns in the PF coils and some mechanical flexibility. The calculations presented were carried out using the specially developed JET equilibrium and configuration analysis codes. (U.K.).

33770 (JET-R–(89)16, pp. 100-106) **Stabilisation of the vertical plasma position.** Noll, P. (Commission of the European Communities, Abingdon (UK). JET Joint Undertaking); Garribba, M. Commission of the European Communities, Abingdon (UK). JET Joint Undertaking. Sep 1989. (CONF-8909326–: Workshop on the new phase for JET: the pumped divertor proposal, Culham (UK), 25-26 Sep 1989). In *JET contributions to the workshop on the new phase for JET: the pumped divertor proposal: Workshop held at JET on 25/26 September 1989.* Order Number DE90625445. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The present radial field amplifier (PRFA) is foreseeably inadequate for the stabilisation of the divertor plasma. The use of a new amplifier with faster response (T_A = .5 ms for voltage step) is considered. (author).

33771 (JET-R–(89)16, pp. 107-132) **The JET divertor coil.** Last, J.R. (Commission of the European Communities, Abingdon (UK). JET Joint Undertaking); Froger, C.; Sborchia, C. Commission of the European Communities, Abingdon (UK). JET Joint Undertaking. Sep 1989. (CONF-8909326–: Workshop on the new phase for JET: the pumped divertor proposal, Culham (UK), 25-26 Sep 1989). In *JET contributions to the workshop on the new phase for JET: the pumped divertor proposal: Workshop held at JET on 25/26 September 1989.* Order Number DE90625445. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The divertor coil is mounted inside the Jet vacuum vessel and is able to carry 1 MA turns. It is of conventional construction - water cooled copper, epoxy glass insulation -and is contained in a thin stainless steel case. The coil has to be assembled, insulated and encased inside the Jet vacuum vessel. A description of the coil is given, together with technical information (including mechanical effects on the vacuum vessel), an outline of the manufacture process and a time schedule. (author).

33772 (JET-R–(89)16, pp. 133-140) **The JET cryopump.** Dietz, J. (Commission of the European Communities, Abingdon (UK). JET Joint Undertaking); Deksnis, E. Commission of the European Communities, Abingdon (UK). JET Joint Undertaking. Sep 1989. (CONF-8909326–: Workshop on the new phase for JET: the pumped divertor proposal, Culham (UK), 25-26 Sep 1989). In *JET contributions to the workshop on the new phase for JET: the pumped divertor proposal: Workshop held at JET on 25/26 September 1989.* Order Number DE90625445. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

Following a feasibility study early in 1989 a number of changes were implemented into the design of the cryopump for the pumped divertor. Calculations on heat and particle loads as well as on pumping speed were carried out and are discussed. In addition a three dimensional Monte Carlo Code on neutral transport has been implemented. Particle removal rates can be derived from given plasma parameters in front of the divertor target plates and the pump geometry. (author).

33773 (JET-R–(89)16, pp. 141-145) **High heat flux components.** Pick, M.A. (Commission of the European Communities, Abingdon (UK). JET Joint Undertaking); Deksnis, E.; Rossi, L. Commission of the European Communities, Abingdon (UK). JET Joint Undertaking. Sep 1989. (CONF-8909326–: Workshop on the new phase for JET: the pumped divertor proposal, Culham (UK), 25-26 Sep 1989). In *JET contributions to the workshop on the new phase for JET: the pumped divertor proposal: Workshop held at JET on 25/26 September 1989.* Order Number DE90625445. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The principle high heat-flux components for the new pumped divertor are the neutraliser or target plates. The outside plates are positioned in such a way as to enhance the flux of hydrogenic neutrals, generated at these plates, into the adjacent cryopump. One of the key concepts behind the divertor design is the radiation of a substantial portion of the plasma power by the plasma in the divertor channels thus reducing the load on the target plates. The radiation will be effected by the impurities sputtered from the target plates and possibly by material injected near the target plates. In order to maintain compatibility with the other plasma facing components and to ensure that the main plasma is not jeopardised, the target plates will be covered with a layer of beryllium. The target plates are being designed with the capability to dissipate a large fraction of the 40 MW of input power under stationary conditions. A system of water cooled components based on the extensive in-house experience with such components gained with the JET neutral beam injection systems is being designed. The average power flux density onto the target plates will be reduced by a sweep of the separatrix over the plates by 6-8 cm. (author).

33774 (JET-R–(89)16, pp. 146-164) **JET ICRH antenna for pumped-divertor geometry.** Bhatnagar, V.P. (Commission of the European Communities, Abingdon (UK)); Jacquinot, J.; Kaye, A. Commission of the European Communities, Abingdon (UK). JET Joint Undertaking. Sep 1989. (CONF-8909326–: Workshop on the new phase for JET: the pumped divertor proposal, Culham (UK), 25-26 Sep 1989). In *JET contributions to the workshop on the new phase for JET: the pumped divertor proposal: Workshop held at JET on 25/26 September 1989.* Order Number DE90625445. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The plasma configuration in the proposed JET programme extending up to 1996 will be a Single-Null (bottom) X-point with a pump divertor. This geometry has important limitations for coupling the RF power by the present ICRH antennas as the plasma size would be smaller and it will be significantly vertically asymmetric. It is clear that the present ICRH antenna (A1) system should be made compatible with the new proposed plasma configuration to utilise the full potential of the 32 MW (generator), 20 s pulse-length, 25-55 MHz JET ICRH installed facility for plasma heating and possible current drive applications in the proposed new phase of the JET programme. The present state-of-the-art knowledge of the antenna design at JET will be used for A2-antenna design which would also incorporate the ICRH current drive features as a prelude to the design of an ICRH launcher of the Next-Step devices. In this design, antennas would be made wider and deeper which would improve the coupling and it is estimated that more than 20 MW can be coupled to X-point plasmas from the ICRH plant. The current drive capability would be improved ($\simeq$ 1 MA) by the use of septums which allow arbitrary phasing between each central conductors. The design philosophy that is being followed in the design of JET A2-antennas is outlined and the present status and the main features of the physics and engineering design of A2-antenna are discussed. The antenna-plasma coupling and the antenna-directivity for the new antenna are then presented. Finally, a time-schedule for the design, construction and installation of the antennas is also given. (author).

33775 (JET-R–(89)16, pp. 165-170) **Modification to the lower hybrid system.** Gormezano, C. (Commission of the European Communities, Abingdon (UK). JET Joint Undertaking). Commission of the European Communities, Abingdon (UK). JET Joint Undertaking. Sep 1989. (CONF-8909326–: Workshop on the new phase for JET: the pumped divertor proposal, Culham (UK), 25-26 Sep 1989). In *JET contributions to the workshop on the new phase for JET: the pumped divertor proposal: Workshop held at JET on 25/26 September 1989.* Order Number DE90625445. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The main modifications which have to be done to the Lower Hybrid system are related in the change of the plasma shape in front of the grill mouth. In effect, the theoretical coupling efficiency of the LHCD grill depends only upon the density at the grill mouth and upon the launched wave index. In order to minimize the number of modifications to the launcher it is proposed to modify the length of the vacuum waveguides connecting the multijunctions to the vacuum windows. To obtain the new poloidal contour, it is proposed to recover the L1 multijunctions and to remachine their mouth. (U.K.).

33776 (JET-R–(89)16, pp. 171-183) **Diagnostic measurements of the pumped divertor plasma.** Gondhalekar, A. (Commission of the European Communities, Abingdon (UK). JET Joint Undertaking); Bartlett, D.; Costley, A. Commission of the European Communities, Abingdon (UK). JET Joint Undertaking. Sep 1989. (CONF-8909326–: Workshop on the new phase for JET: the pumped divertor proposal, Culham (UK), 25-26 Sep 1989). In *JET contributions to the workshop on the new phase for JET: the pumped divertor proposal: Workshop held at JET on 25/26 September 1989.* Order Number DE90625445. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The scope of plasma diagnostic capability needed for the pumped divertor is determined by the measurement objectives, which are: (i) to demonstrate feasibility of impurity control using a high flow rate divertor, (ii) to validate a model of the divertor action, and (iii) to optimize pumped divertor performance. Installation of diagnostics, with spatial resolution along the separatrix in the divertor region between the x-point and the target plates, is proposed. Difficult access, small plasma size, large dynamic range, and interpretational issues determine the choices of diagnostic methods which have been made. (author).

33777 (JET-R–(89)16, pp. 184-196) **Performance expectations in the new configuration.** Lallia, P.P. (Commission of the European Communities, Abingdon (UK). JET Joint Undertaking); Rebut, P.-H. Commission of the European Communities, Abingdon (UK). JET Joint Undertaking. Sep 1989. (CONF-8909326–: Workshop on the new phase for JET: the pumped divertor proposal, Culham (UK), 25-26 Sep 1989). In *JET contributions to the workshop on the new phase for JET: the pumped divertor proposal: Workshop held at JET on 25/26 September 1989.* Order Number DE90625445. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The pumped divertor to be installed in JET should allow a control of the particles and of the impurities. The new hardware required into the vacuum vessel leads to a reduction of the plasma

cross section. While a plasma current of 6 MA should still be possible, this will affect the confinement of the plasma. The JET performances in the New Configuration are estimated from the critical electron temperature gradient model by using a 1-D transport code. It has been shown in the past that this model gives a rather satisfactory description of the JET discharges. However it does not address the particle transport and density profiles have to be imposed. By comparison with numerical simulations of the present JET configuration, it is shown that the reduction in plasma size should be more than balanced by the lower impurity concentration expected to result from the divertor. In terms of thermonuclear Q_{th}, a doubling is found relatively to the expectations in the present configuration ($\simeq$ .9 against .45). On the other hand Q_{th} should be lowered to .3 if the impurity control is inefficient. In this case as presently observed in JET it is expected that no steady state will be achieved. (author).

33778 (Juel–2339) **Measurement of the internal magnetic field structure of tokamak plasmas.** Soltwisch, H. Forschungszentrum Juelich GmbH (Germany, F.R.). Inst. fuer Plasmaphysik; Association Euratom-Kernforschungsanlage Juelich GmbH (Germany, F.R.). Jan 1990. 116p. (In German). Order Number DE90792214. Available from NTIS (US Sales Only), PC A06/MF A01.

The first part of this article deals with the physical fundaments and technical aspects of this polarimetric measuring method, with its diagnostic capability, but also with its limitations. The second part summarizes the essential experimental results and their feedback on the theoretical description of Tokamak plasmas, which caused a revision of the accepted ideas of the magnetic field structure and its magnetohydrodynamic stability, in particular in the area of the hot plasma core. (orig.).

33779 (Juel–2342) **Burn condition for fusion plasmas, helium particle confinement and exhaust efficiency.** Reiter, D.; Wolf, G.H.; Kever, H. Forschungszentrum Juelich GmbH (Germany, F.R.). Inst. fuer Plasmaphysik; Association Euratom-Kernforschungsanlage Juelich GmbH (Germany, F.R.). Jan 1990. 34p. (CONF-891288–: 8. European tokamak programme workshop, Gut Ising (Germany, F.R.), 13-15 Dec 1989). Order Number DE90792211. Available from NTIS (US Sales Only), PC A03/MF A01.

The burn condition for D-T plasmas is derived in a form which acounts for the stationary helium concentration being selfconsistently determined by the coupling of the fusion power and helium production. The ratio of the global α-particle confinement time τ_α^* (definition in the text) to the energy confinement time τ_E is taken as a qunatity characterizing the prevailing confinement and exhaust regime. It is shown that for an ignited and stationary burning D-T plasma this ratio needs to remain sufficiently below 15 (or below 10 for typical impurity concentrations). This poses a lower limit to the required helium exhaust efficiency and indicates that operational regimes might be desirable where the internal particle confinement time does not diverge too far from and in excess of the energy confinement time, and where the boundary layer - e.g. through high particle density and outward flow - acts as a sufficient shield against recycled α-particles. It is further demonstrated that for any given temperature (and for otherwise equal overall exhaust and recycling conditions) either burning can be achieved at two quite different values of the fusion parameter (triple product $nxTx\tau_E$) and ash concentrations (one at low concentrations in the range 5-20%, the other in the range of 20-35%) or not at all. A similar evaluation applied to the D-^{3}He fusion reaction leads to even more stringent limits on the ratio τ_α^*/τ_E, which must be smaller by a factor 3 to 4 compared to the D-T case. (orig.).

33780 (KEK–89-14, pp. 63-72) **Cross-field acceleration in plasmas.** Takeuchi, S. (Yamanashi Univ., Kofu (Japan). Faculty of Engineering); Sakai, K.; Matsumoto, M. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Oct 1989. (CONF-8908213–: Workshop on role of plasmas in accelerators, Tsukuba (Japan), 21 Aug 1989). In *Proceedings of the workshop on role of plasmas in accelerators.* Order Number DE90759999. Available from NTIS (US Sales Only), PC A06/MF A01.

A new mechanism of high-energy particle generation in magnetized plasmas is presented. The particle trapped by an elliptically polarized electromagnetic wave propagating across a static magnetic field B_0 is unlimitedly accelerated in principle. The trapping condition depends on the ratio E_1/B_0, the polarization and the phase velocity of the wave where E_1 is the magnitude of the electric field of the wave. The particle acceleration by the extraordinary wave and a plasma shock wave that are externally excited in magnetized plasmas are shown as examples of high-energy particle generation. (author).

33781 (KEK–89-14, pp. 81-97) **Nonlinear effects in plasma wake field acceleration (PWFA).** Amatuni, A.Ts. (Erevanskij Fizicheskij Inst., Erevan (USSR)). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Oct 1989. (CONF-8908213–: Workshop on role of plasmas in accelerators, Tsukuba (Japan), 21 Aug 1989). In *Proceedings of the workshop on role of plasmas in accelerators.* Order Number DE90759999. Available from NTIS (US Sales Only), PC A06/MF A01.

The results of theoretical studies on nonlinear plasma wake field acceleration at the Yerevan Physics Institute (YerPhI) during the past years are given; the dependence of the wake field, the transformation ratio on the bunch Lorentz factor and the possibility of self-acceleration of relativistic bunch electrons are considered. The influence of ion motion and the finite lateral dimensions of the bunch is taken into account. In parallel with results obtained at YerPhI we discuss also the state-of-art and the future trends in the relevant directions of research. (author).

33782 (KFK–4692) **Parallel treatment of simulation particle-in-cell codes on SUPRENUM.** Seldner, D. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Datenverarbeitung in der Technik. Feb 1990. 83p. Contract BMFT ITR8502K/4. Order Number DE90792222. Available from NTIS (US Sales Only), PC A05/MF A01.

This report contains the program documentation and description of the program package 2D-PLAS, which has been developed at the Nuclear Research Center Karlsruhe in the institute for Data Processing in Technology (IDT) under the auspices of the BMFT. 2D-PLAS is a parallel program version of the treatment of the simulation particles of the two-dimensional stationary particle-in-cell code BFCPIC which has been developed at the Nuclear Research Center Karlsruhe. This parallel version has been designed for the parallel computer SUPRENUM. (orig.).

33783 (KFKI–1989-41/D) **Impurity flux collection at the plasma edge of the tokamak MT-1.** Hildebrandt, D. (Akademie der Wissenschaften der DDR, Berlin (German Democratic Republic). Zentralinstitut fuer Elektronenphysik); Bakos, J.S.; Petravich, G. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Sep 1989. 31p. Order Number DE90627431. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Review of Scientific Instruments (USA).

Fluxes of intrinsic and injected impurities and background plasma ions were collected using a bidirectional probe at the plasma edge of the tokamak MT-1. The directional and radial dependences of injected impurities and plasma ions were very similar indicating a strong coupling of the impurity transport to the dynamics of the background plasma. The measured intrinsic concentration of about 10^{-4} for Mo at the plasma edge is derived. (author) 17 refs.; 5 figs.

33784 (LRP–381/89) **Measurement of the ion temperature in the tokamak TCA by collective Thomson diffusion in the far infrared.** Salito, S.A. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)). Ecole Polytechnique Federale, Lausanne (Switzerland). Jul 1989. 154p. (In French). Order Number DE90627367. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

This paper covers the analysis of spectra obtained by collective Thomson diffusion and the measurement, by this method, of the ionic temperature in the plasmas of the TCA tokamak. The experimental equipment we have used consists of a D_2O laser and of a heterodyne detection system analyzing the spectra diffused by the plasma. The diffused spectra were obtained using a geometry determining a diffusion angle Θ_s of 90°. We could choose two different

angles β between the wave vector k and the direction of the magnetic field (β=90°, β=86°). We have performed the measurement of the coherent (collective) spectrum in the hydrogen, deuterium and helium plasmas of the TCA tokamak. When the electron density exceeded $4x10^{19}$ m^{-3}, the diffused spectra were analyzed on the basis of a single laser shot of 1.4 μs duration. The ionic acoustic resonance was observed in the helium plasma for an angle β of 86°. When β was 90°, we observed that the experimental spectra were heavily disturbed by the effects of the magnetic field, and their shapes became triangular. A small concentration of light impurities affected the shape of the spectra up to their extremities. By collective diffusion we could measure the typical ionic temperatures of 330 eV for the hydrogen plasmas and of 390 eV for the deuterium and helium plasmas. The precision of this measurement was 10% at an average of 10 shots, and it was 25% for a single measurement of 1.4 μs duration. It is mainly limited by the signal/noise ratio which is in the order of 3 for one measurement during a single laser shot of 1.4 μs. (author) 70 figs., 5 tabs., 106 refs.

33785 (PPPL–2666) **Temperature distribution of a tokamak with a constant heat conductivity.** Yoshikawa, S. Princeton Univ., NJ (USA). Plasma Physics Lab. May 1990. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90010344. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

An analytical expression of the detached plasma radius in and ohmically heated tokamak plasma was obtained. The assumption was made that the (anomalous) heat conductivity is constant and independent of minor radius, r. The resultant nonlinear differential equation has a universal solution for the plasma temperature as a function of r. The shape is very similar to the so-called profile consistency model. As the average plasma density increases, the tokamak plasma which is first attached to either limiter or divertor detaches itself from the limiter and forms a toroidal plasma whose boundary is clearly marked by a radiative boundary layer where the power input to the plasma is radiated away. As the plasma density increases, the radius of the plasma shrinks until the surface safety factor becomes less that ~2, whereupon the plasma disruption starts. The density limit calculated by this model agrees with the experimental observation. 1 ref., 1 fig., 1 tab.

33786 (TRITA-PFU–88-11) **A survey of theoretical research on the EXTRAP concept.** Lehnert, B. Royal Inst. of Tech., Stockholm (Sweden). Dept. of Plasma Physics and Fusion Research. Dec 1988. 47p. Order Number DE90627358. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A review is given of the theoretical analysis on the Extrap concept which consists of a Z-pinch being immersed in an octupole field generated by currents in a set of external conductors. This analysis includes research on plasma breakdown and start-up, equilibrium and stability, in terms of MHD and kinetic theory. Extrap theory includes an extensive area of diversified problems, being related to a high beta value, a non-circular plasma cross section with a magnetic separatrix, and strongly inhomogeneous plasma conditions in space. This also leads to unexplored and important areas of plasma physics, reaching far beyond the special applications to the Extrap configuration. At present progress has been made in the analysis of breakdown, of dissipation-free equilibria, and in identifying the instability modes and possible stabilizing meachanisms in Extrap. Nevertheless much work still remains within the area of dissipative equilibria and transport, as well as in the efforts to reach a complete theoretical understanding of the experimentally observed stability. (115 refs.).

33787 (UCRL-ID–103473) **Characterization of disruptions in the Microwave Tokamak Experiment, MTX.** Hooper, E.B. (Lawrence Livermore National Lab., CA (USA)); Makowski, M.A. Lawrence Livermore National Lab., CA (USA). 30 Mar 1990. 35p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. Order Number DE90010352. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Microwave Tokamak Experiment (MTX) has a substantial number of fast diagnostics, especially for electrons, as part of its mission for pulsed, high-power electron cyclotron heating. As part of its contribution to ITER R&D, these diagnostics are being used to characterize disruptions in MTX. This report is the first of two, with the second planned for submittal in September 1990, at the end of the ITER conceptual design activity. Here, we analyze the characteristics of disruptions during normal operation of MTX, discuss some new data pertaining to the "Granetz limit," and describe preliminary data on ramped density shorts which will be used for fast measurements on density limit disruptions. The final report will discuss measurements using the fast diagnostics to characterize the disruption.

33788 Measurements of heating and energy storage in diode-pumped Nd YAG. Chen, T.S. (Hughes Aircraft Co., El Segundo, CA (US)); Anderon, V.L.; Kahan, O. *IEEE Journal of Quantum Electronics (Institute of Electrical and Electronics Engineers) (USA),* 26(1): 6-8 (Jan 1990).

The authors have experimentally measured the stored energy and the heat generated in diode-pumped Nd:YAG. The heat parameter χ, defined as the heat deposited per unit of stored energy, is found to be 1.1 in a 200 μs pump pulse, about one-third of the value of flashlamp-pumped Nd:YAG. Without fluorescence decay, the χ is 0.7.

33789 X-ray detection using the quantum well exciton nonlinearity. Eugster, C.C. (Research Lab. of Electronics, Massachusetts Institute of Technology, Cambridge, MA (US)); Hagelstein, P.L. *IEEE Journal of Quantum Electronics (Institute of Electrical and Electronics Engineers) (USA),* 26(1): 75-84 (Jan 1990).

Two related schemes for detecting x-rays based on the scattering and the reflection of a pulsed optical probe beam by carriers produced by the absorption of a single energetic x-ray photon are described. The detection method is based on the strong carrier density dependence of the (complex) index of refraction of the exciton absorption lines in a GaAs/AlGaAs multiple-quantum-well structure. These schemes may be sued to construct a new class of very sensitive gated x-ray detectors with micron spatial resolution and temporal resolution in the 10–30 ps regime.

33790 CW ultraviolet and visible laser action from ionized silver in an electron beam generated plasma. Wernsman, B. (Dept. of Electrical Engineering, Colorado State Univ., Fort Collins, CO (US)); Rocca, J.J.; Mancini, H.L. *IEEE Photonics Technology Letters (Institute of Electrical and Electronics Engineers) (USA),* 2(1): 12-14 (Jan 1990). Grant 87-0290.

This paper reports continuous wave laser oscillation obtained in the 318.1 nm and the 478.8 nm lines of AgII in a neon-silver vapor mixture excited by glow discharge electron beams. Laser output powers of 14 and 60 mW were obtained in the ultraviolet and blue transitions, respectively, using nonoptimized optical cavities.

33791 Fracto-emission from deuterated titanium: Supporting evidence for a fracto-fusion mechanism. Dickinson, J.T. (Washington State University, Pullman, Washington 99164-2814 (US)); Jensen, L.C.; Langford, S.C.; Ryan, R.R.; Garcia, E. *Journal of Materials Research (USA),* 5(1): 109-122 (Jan 1990).

Measurements of the emission of charged particles, photons, and radio frequency signals accompanying the deformation and fracture of polycrystalline Ti metal and deuterated Ti are described. Preliminary evidence for charge separation created by crack propagation is presented which supports a proposed fracture mechanism to explain neutron bursts observed during treatment of deuterated metals.

33792 H^0 temperature and density measurements in a Penning surface-plasma H^- ion source. I. Smith, H.V. Jr. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)); Allison, P.; Pitcher, E.J.; Stevens, R.R. Jr.; Worth, G.T.; Stutzin, G.C.; Young, A.T.; Schlachter, A.S.; Leung, K.N.; Kunkel, W.B. *Review of Scientific Instruments (USA),* 61(1): 424-426 (Jan 1990). DOE Contract AC03-76SF00098. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

Using vacuum ultraviolet laser-absorption spectroscopy, the H^0 density and temperature are measured as a function of discharge current and H_2-gas flow in both the plasma column and the drift region between the plasma column and the emitter in the 4X source. For typical source operating parameters, the atom temperature is 1.5 eV in the plasma column and 0.6 eV in the drift region; the atom

density 7×10^{14} cm^{-3} in the plasma column and 4×10^{14} cm^{-3} in the drift region. Separate measurements give 2% for the ratio of H_2 molecules in the first vibrational level to the total H_2 density.

33793 Influence of an energetic ion population on tokamak plasma stability. White, R.B. (Associazione EURATOM-ENEA sulla Fusione, CRE Frascati, C.P. 65, 00044, Frascati, Rome, Italy (IT)); Romanelli, F.; Bussac, M.N. *Physics of Fluids B (USA),* 2(4): 745-753 (Apr 1990). DOE Contract AC02-76CH03073.

The stability of a tokamak plasma to ideal and resistive internal kink modes in the presence of an energetic trapped-particle population is analyzed. Domains of stability are found for both slowing-down and Maxwellian particle distributions. The stable domains are at moderately high plasma beta and involve a significant, but easily obtainable high-energy trapped-particle density.

33794 Neoclassical quasilinear transport theory of fluctuations in toroidal plasmas: Further considerations. Shaing, K.C. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831 (USA)). *Physics of Fluids B (USA),* 2(4): 764-772 (Apr 1990). DOE Contract AC05-84OR21400.

The effects of the radial electric field E_r on fluctuation-induced transport fluxes and the fluctuation spectrum in toroidal plasmas are further studied to clarify the ideas originally developed in an earlier paper [Phys. Fluids **31**, 2249 (1988)]. A specific tokamak example is employed in the discussion. It is found that even in the presence of fluctuations, the parallel flow in tokamaks is damped by the neoclassical viscosity on a time scale of the order of ν_{ii}^{-1}, with ν_{ii} the collision frequency. The toroidal flow is damped by the anomalous ion viscosity on a time scale of the order of the confinement time. The radial electric field always has an effect on the fluctuation spectrum and fluctuation-induced transport fluxes in tokamaks except when $d(E_r q/r)/dr=0$ (where q is the safety factor and r is the minor radius) if the radial dependence of the toroidal magnetic field is neglected by considering the invariant property of the drift kinetic equation when there is a change in E_r. The condition implies the rigid-body toroidal rotation associated with $\mathbf{E}\times\mathbf{B}$ drift, with **E** (**B**) the electric (magnetic) field. The fact that the fluctuation-induced transport fluxes can depend on E_r through the fluctuation spectrum and the thermodynamic force does not contradict their intrinsic ambipolarity property. The results are shown to be invariant under Galilean transformation.

33795 Computer simulation of Alfven wave heating. Geary, J.L. (Institute for Fusion Studies, University of Texas at Austin, Austin, Texas 78712 (USA)); Leboeuf, J.; Tajima, T. *Physics of Fluids B (USA),* 2(4): 773-786 (Apr 1990). DOE Contract FG05-80ET53088.

A particle simulation study of shear Alfven wave resonance heating is presented. A particle simulation model has been developed for this application that incorporates Darwin's formulation of the electromagnetic fields with a guiding center approximation for electron motion perpendicular to the ambient magnetic field. With this model, several cases of Alfven wave heating are examined in both uniform and nonuniform simulation systems in a two-dimensional slab. When the antenna parameters match the shear Alfven resonance condition, the simulation plasmas in the homogeneous cases react strongly with the driven wave. For the inhomogeneous case studies, the kinetic Alfven wave develops in the vicinity of the shear Alfven resonance region. The electrons kinetically react with the wave through a collisionless process. The electron velocity distribution function flattens about the parallel phase velocity of the wave with accompanying changes in the spatial structure of the wave. The electron heating rate is in good agreement with the Landau damping model. A substantial electron current is also generated parallel to the applied magnetic field. The ions gain energy by oscillating in the wave electric fields.

33796 Mode conversion between Alfven wave eigenmodes in axially inhomogeneous two-ion-species plasmas. Roberts, D.R. (Department of Nuclear Engineering— Department of Engineering Physics, University of Wisconsin, Madison, Wisconsin 53706 (USA)); Hershkowitz, N.; Tataronis, J.A. *Physics of Fluids B (USA),* 2(4): 787-796 (Apr 1990). DOE Contract FG02-88ER53264.

The uniform cylindrical plasma model of Litwin and Hershkowitz [Phys. Fluids **30**, 1323 (1987)] is shown to predict mode conversion between the lowest radial order $m=+1$ fast magnetosonic surface and slow ion-cyclotron global eigenmodes of the Alfven wave at the light-ion species Alfven resonance of a cold two-ion plasma. A hydrogen (h)–deuterium (d) plasma is examined in experiments. The fast mode is efficiently excited by a rotating field antenna array at $\omega\sim\Omega_h$ in the central cell of the Phaedrus-B tandem mirror [Phys. Rev. Lett. **51**, 1955(1983)]. Radially scanned magnetic probes observe the propagating eigenmode wave fields within a shallow central cell magnetic gradient in which the conversion zone is axially localized according to n_d/n_h. A low radial-order slow ion-cyclotron mode, observed in the vicinity of the conversion zone, gives evidence for the predicted mode conversion.

33797 The ion temperature gradient instability in a linear machine. Mathey, O. (Plasma Research Laboratory, Columbia University, New York, New York 10027 (USA)); Sen, A.K. *Physics of Fluids B (USA),* 2(4): 725-733 (Apr 1990). DOE Contract FG02-87ER53257.

It is shown that anisotropy in the ion temperature gradient has a substantial effect on the ion temperature gradient driven mode. A gradient in the parallel temperature is needed for an instability to occur and a gradient in the perpendicular temperature gradient further enhances the instability indirectly as long as the frequency of the mode is near ion resonance. The physical reason for this important role difference is presented. The Columbia Linear Machine (CLM) [Phys. Rev. Lett. **57**, 1729 (1986)] is being redesigned to produce and identify the ion temperature gradient driven η_i mode. Using the expected parameters, detailed predictions of the mode characteristics in the CLM have been developed. These include growth rate and real frequency as a function of the azimuthal number m, the drive parameter $\eta_i \equiv d(\ln T_i)/d(\ln n)$, and the parallel wavenumber $k_\parallel$. Strong multimode instabilities are expected. Because the ion parallel and perpendicular ion temperature gradients are expected to differ significantly, the roles of $\eta_{i\parallel}$ and $\eta_{i\perp}$ are differentiated, and this difference is exploited for a stabilization scheme of the mode. Since all gradients are significantly variable over the expected radial wavelength of the mode, a nonlocal radial differential equation has been derived. With some approximations, this can be reduced to a Weber-type equation, which has been solved.

33798 Canonical Hamiltonian guiding center variables. White, R.B. (Princeton Plasma Physics Laboratory, Princeton, New Jersey 08543 (USA)). *Physics of Fluids B (USA),* 2(4): 845-847 (Apr 1990). DOE Contract AC02-76CH03073.

A simplification of the canonical Hamiltonian variables for the guiding center motion of a charged particle in a general toroidal field is obtained using the Lagrangian formalism.

33799 Safety factor on the axis of a tokamak during Ohmically heated sawtoothing discharges from a localized measurement of circular polarization of the Li I 6708 A line. Huang, L.K. (The Johns Hopkins University, Baltimore, Maryland 21218 (USA)); Finkenthal, M.; Wroblewski, D.; Moos, H.W.; West, W.P.; Thomas, D.M.; Thomas, M.P.; Yang, X.Z.; Phillips, P.E.; Wootton, A.J. *Physics of Fluids B (USA),* 2(4): 809-814 (Apr 1990). DOE Contract FG02-86ER53214;AC03-84ER53158.

Analysis of the circular polarization of the Li I 6708 A line emitted from a monoenergetic lithium beam provides a spatially resolved measurement of the poloidal magnetic field on the Texas experimental tokamak [Nucl. Technol. Fusion **1**, 479 (1989)]. Determined from the measured magnetic field, the safety factor on the magnetic axis during Ohmically heated sawtoothing discharges is near unity.

33800 Effect of changes in viewing window transmission on high-temperature Thomson scattering data. McNeill, D.H. (Princeton Research Forum, P. O. Box 497, Princeton, New Jersey 08542 (USA)). *Review of Scientific Instruments (USA),* 61(4): 1263-1266 (Apr 1990). DOE Contract AC02-76CH03073.

Unmonitored changes in the transmission of viewing windows owing to deposited films can produce errors in Thomson scattering temperature measurements. This effect is illustrated by a recent run on the Tokamak Fusion Test Reactor (TFTR) where apparent errors of over 25% in peak temperatures of 9 keV owing to carbon

films were noted. Since coatings can also be removed by hydrogen discharges, the transmission of a window may change with time, resulting in variable errors in the temperature. It is proposed that these changes be monitored by calibration *in situ* with the aid of a low-pressure hydrogen glow discharge.

33801 **Sources of multiply charged ions for heavy-ion fusion.** Humphries, S. Jr. (Acceleration Consultants, Albuquerque, New Mexico 87122 (USA)); Rutkowski, H. *Journal of Applied Physics (USA)*, 67(7): 3223-3232 (1 Apr 1990).

We report experiments on methods to raise the proportion of multiply charged ions for high-flux-ion extraction from vacuum-arc plasma sources. Beams of doubly and triply charged ions have application to induction linacs for heavy-ion fusion. We confirmed that the arc cathode material strongly influenced the ion-charge-state proportions. We believe the electrostatic potential of the plasma streaming from the arc played a major role in the transport of multiply charged ions. Reduction of electron losses from the plasma increased the observed fluxes of doubly charged ions. We inhibited electron loss and enhanced the flux of multiply charge ions by applying a bias voltage to the plasma source and by adding an axial magnetic field. We also investigated a method to increase the proportion of multiply charged ions by time-of-flight separation following rapid switching of the expanding plasma. We developed a new arc-source geometry for the experiments. The source had a hollow anode and an axial magnetic field to anchor the position of emission spots on the cathode.

7002 Fusion Power Plant Technology

Refer also to citation(s) 32538, 32710, 32865, 32890, 32902, 32937, 33386, 33732, 33763, 33790

33802 (ANU-PRL-PP–89/6) **Papers presented at seventh international workshop on stellarators.** Australian National Univ., Canberra (Australia). Plasma Research Lab. 1989. 32p. (CONF-890403–: 7. international workshop on stellarators, Oak Ridge, TN (USA), 10-14 Apr 1989). Order Number DE90625560. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Four of these papers describe research work at SHEILA, one of the two heliac stellarators at the Australian National University (ANU). They discuss configurational effects on plasma confinement, experimental studies on drift waves, electron beam measurements using a simple method of image intensification, and electron cyclotron heating experiments. The remaining three papers present aspects of the ANU's other stellarator, the H-1 flexible heliac currently under construction. Vacuum field optimization and effects of field errors on the flux surfaces of the H-1 heliac are discussed. A novel scanning, heterodyne interferometer, which employs a rotating disc grating as the scanning and frequency shifting element and which possesses a truly tomographic capability, is described. The H-1's ion cyclotron heating system is discussed. Refs., figs., tabs.

33803 (ANU-PRL-PP–89/6, pp. 19-22) **Vacuum field optimization and the effects of field errors on the flux surfaces of the H-1 Heliac.** Blackwell, B.D.; Tou, T.Y.; Zhou, D.F.; Sharp, L.E. Australian National Univ., Canberra (Australia). Plasma Research Lab. 1989. (CONF-890403–: 7. international workshop on stellarators, Oak Ridge, TN (USA), 10-14 Apr 1989). In *Papers presented at seventh international workshop on stellarators.* Order Number DE90625560. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The H-1 heliac configuration has been optimized for low aspect ratio and minimum B ripple by modulation of the toroidal spacing of the toroidal field coils, and by optimization of the vertical field magnitude and index. Two numerical studies of symmetry breaking error configurations are presented, a displacement of the central conductor and a stray field modelled by a dipole. The rate of growth of island size with the error magnitude Δx is found to increase from the expected $(\Delta x)^{1/2}$ scaling to Δx scaling within the range of errors to be expected for H-1. It is expected that the island size in the central 75% of the plasma volume can be limited to 10mm. Presented is a preliminary investigation of compensation of the toroidal coil position errors by adjustment of the position of the ring conductor. 6 figs.

33804 (CONF-891007–120) **The measurement of gamma heating in a fusion blanket test assembly.** Chiu, H.K. (Illinois Univ., Urbana, IL (USA)); Bennett, E.F.; Micklich, B.J. Argonne National Lab., IL (USA). [1989]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 13. IEEE symposium on fusion engineering; Knoxville, TN (USA); 2-6 Oct 1989. Order Number DE90011154. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Determining the distribution of gamma heating in fusion test assemblies will help guide the construction and operation of future experiments. Currently the dominant technique for spatial characterization of heating is the wide dispersal of thin film TLD's, which are limited to measurement of the total neutron + gamma dose. The present work measures heating using calibrated proportional counters, which allows for the rejection of fast pulse-rise events characteristic of ionizations produced by neutron induced atomic recoils. A coupled calculational and experimental program designed to demonstrate this capability has been initiated at ANL. An irradiation assembly composed of graphite-filled 5 x 5 x 61 cm Mg sleeves in cubic geometry was constructed. This assembly was then irradiated in turn with Co-60 gammas and 14.8-MeV neutrons produced by a D-T neutron generator in two sets of measurements with the proportional counter occupying various positions in the central channel of the assembly. Calculation of the expected dose in the assembly due to the sources at the positions of interest were made. These calculations first generated the neutral flux profile in the assembly with either ANISN or MCNP depending on the degree of detailed used in the modelling of the counter. The profile is then fed into a charged-particle generation model to obtain the charged-particle profiles, hence energy deposition in the assembly. A comparison was made between these calculations of the energy deposition and measured energy deposition in the assembly. It is hoped that by understanding this comparison a clear picture of gamma heating in a mixed gamma and neutron environment will be obtained.

33805 (CONF-891204–33) **Desorption of H_2O and H_2 from steel and $LiAlO_2$ by temperature programmed desorption.** Fischer, A.K.; Johnson, C.E. Argonne National Lab., IL (USA). [1989]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 4. international conference on fusion reactor materials; Kyoto (Japan); 4-8 Dec 1989. Order Number DE90011170. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Temperature programmed desorption (TPD) measurements with a steel sample tube and helium sweep gas in progress to provide data describing the kinetics of desorption of $H_2O(g)$ and $H_2(g)$ from ceramic tritium breeders. Preliminary blank experiments indicated that the steel can be a reactive participant with H_2O being consumed and H_2 being evolved. There is also evidence of some dissolution of H_2 in the steel. However, it is possible to stabilize the steel in the absence of added H_2 so that useful desorption measurements with $H_2O(g)$ can be made. Initial work was on the $LiA1O_2$ – $H_2O(g)$ system. Fresh samples of $LiA1O_2$ bear large amounts of absorbed H_2O. TPD spectra were measured for $LiA1O_2$ that had been equilibrated in a helium stream with 200 ppm $H_2O(g)$ at temperatures from 473 to 773 K. Several techniques of data analysis were applied. Questions of possible peak overlap still remain to be resolved. An activation energy for desorption of $H_2O(g)$ of approximately 120 kJ/mol appears to be associated with the sample equilibrated at 673 K. This result agrees with the values reported in the literature for decomposition of LiOH, and suggests that some sites on $LiA1O_2$ might resemble sites on Li_2O on their adsorptive properties. For a 773 K equilibration, the activation energy of desorption appears considerably higher. 6 refs., 4 figs.

33806 (CONF-900505–2) **The effects of chromium and titanium gettering on the operation of the Advanced Toroidal Facility.** Isler, R.C.; Bell, G.L.; Bigelow, T.S.; Crume, E.C.; England, A.C.; Glowienka, J.C.; Hiroe, S.; Horton, L.D.; Jernigan, T.C.; Langley, R.A. Oak Ridge National Lab., TN (USA). [1990]. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 9. plasma interaction conference; Bournemouth (UK); 20-25 May 1990. Order Number DE90011390. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Plasmas in the Advanced Toroidal Facility (ATF), an $\ell = 2$ torsatron with 12 field periods, are produced by 200–400 kW of electron cyclotron heating (ECH) and up to 1.5 MW of neutral-beam injection (NBI). The characteristics of the plasmas are sensitive to the type of wall conditioning employed. A progression of techniques, beginning with glow discharge cleaning and baking and evolving to gettering with chromium and titanium, has significantly reduced the low-Z impurity content, lowered the fraction of radiated power, and permitted improved control over the electron density. As a result, plasma parameters and machine performance have been enhanced significantly. The maximum values achieved for storage energy, line-averaged density, and confinement times are 28 kJ, 1.2×10^{20} m^{-3}, and 25 ms. These parameters are comparable to those obtained in the ISX-B tokamak. In addition, with titanium gettering, quasisteady operation of 200 ms of neutral beam injection has been obtained without the collapses that characterized earlier periods of operation. 4 refs., 4 figs., 1 tab.

33807 (CONF-900519–1) **The insulation irradiation test program for the Compact Ignition Tokamak.** McManamy, T.J. (Oak Ridge National Lab., TN (USA)); Kanemoto, G.; Snook, P. Oak Ridge National Lab., TN (USA). [1990]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400;AC07-76ID01570. From Nonmetallic materials and composites at low temperatures; Heidelberg (Germany, F.R.); 17-18 May 1990. Order Number DE90011318. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The electrical insulation for the toroidal field coils of the Compact Ignition Tokamak (CIT) is expected to be exposed to radiation doses on the order of 10^{10} rad with ≈90% of the dose from neutrons. The coils are cooled to liquid nitrogen temperature and then heated during the pulse to a peak temperature >300 K. In a program to evaluate the effects of radiation exposure on the insulators, three types of boron-free insulation were irradiated at room temperature in the Advanced Technology Reactor (ATR) and tested at the Idaho National Engineering Laboratory. The materials were Spaulrad-S, Shikishima PG5-1, and Shikishima PG3-1. The first two use a bismaleimide resin and the third an aromatic amine hardened epoxy. Spaulrad-S is a two-dimensional (2-D) weave of S-glass, while the others are 3-D weaves of T-glass. Flexure and shear/compression samples were irradiated to approximately 5×10^9 rad and 3×10^{10} rad with 35 to 40% of the total dose from neutrons. The shear/compression samples were tested in pairs by applying an average compression of 345 MPa and then a shear load. After static tests were completed, fatigue testing was done by cycling the shear load for up to 30,000 cycles with a constant compression. The static shear strength of the samples that did not fail was then determined. Generally, shear strengths on the order of 120 MPa were measured. The behavior of the flexure and shear/compression samples was significantly different; large reductions in the flexure strength were observed, while the shear strength stayed the same or increased slightly. The 3-D weave material demonstrated higher strength and significantly less radiation damage than the 2-D material in flexure but performed nearly identically when tested with combined shear and compression. The epoxy system was much more sensitive to fatigue damage than the bismaleimide materials. 9 refs., 5 figs.

33808 (DOE/ER/52147–T1) **Microwave generation for magnetic fusion energy applications, Task B: Progress report, September 15, 1989–September 14, 1990.** Antonsen, T.M. Jr.; Destler, W.W.; Granatstein, V.L.; Levush, B.; Mayergoyz, I.D.; Singh, A. Maryland Univ., College Park, MD (USA). May 1990. 40p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER52147. Order Number DE90011079. Available from NTIS, PC A03/MF A01; OSTI; INIS.

One of the main issues in the development of high power gyrotrons is the present discrepancy between the theoretically predicted efficiency and that observed in the experiments. Recent 140 GHz experiments by MIT employed three cavities; two of the cavities have different interaction lengths and the third cavity is a complex two-section cavity. In all cases, the maximum experimental efficiency is well below the theoretically predicted one. A better theoretical understanding of the causes of these discrepancies is essential to the scaling of gyrotrons to higher power and higher frequency. We continued our investigation with the objective of determining whether mode competition and velocity spread in the electron beam could in some way be influencing the current result from the MIT 140 GHz gyrotrons experiments and determining to what extent these effects would influence operation of a 1 MW, 280 GHz, $TE_{42,7}$ gyrotron as conceived at MIT. In our investigations, we used two models, the "fixed axial field profile" model and the "self-consistent determination of the axial field profile" model. With the "fixed axial field profile" model we studied the effect of thermal spread on the efficiency of gyrotrons operation, mode competition between unequally spaced modes, and we simulated the start up of the MIT 140 GHz gyrotrons. Our main conclusions from all these studies are discussed in this paper.

33809 (DOE/ER/52147–T2) **Microwave generation for magnetic fusion energy applications, Task C: Progress report, September 15, 1989–September 14, 1990.** Antonsen, T.M. Jr.; Destler, W.W.; Granatstein, V.L.; Levush, B.; Mayergoyz, I.D.; Singh, A. Maryland Univ., College Park, MD (USA). May 1990. 29p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER52147. Order Number DE90011080. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report discusses: depressed collectors for a radially extracted beam; depressed collectors for quasi optical gyrotrons; general approach to design of depressed collectors; and effect on α of non-adiabatic changes in B-field.

33810 (DOE/ER/53198–154) **The Madison Symmetric Torus.** Dexter, R.N.; Kerst, D.W.; Lovell, T.W.; Prager, S.C.; Sprott, J.C. Wisconsin Univ., Madison, WI (USA). Dept. of Physics. Mar 1990. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-85ER53198. Order Number DE90010306. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Madison Symmetric Torus (MST) is the newest and largest reversed field pinch presently in operation. It incorporates a number of design features that set it apart from other pinches, including the use of the conducting shell as both a vacuum vessel and single-turn toroidal field coil. Specially insulated voltage gaps are exposed to the plasma. Magnetic field errors at these gaps as well as at the various diagnostic and pumping ports are minimized through a variety of techniques. The physics goals of MST include study of the effect of large plasma size on confinement and the investigation, in detail, of RFP turbulence, dynamo and transport. Details of the design and initial operation of the device are presented.

33811 (DOE/ER/53267–3) **Texas Experimental Tokamak: Technical progress report, April 1989–April 1990.** Wootton, A.J. Texas Univ., Austin, TX (USA). Fusion Research Center. Apr 1990. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER53267. Order Number DE90011070. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the following work on the text tokamak: data systems; particle confinement; impurity transport; plasma rotation; runaway electrons; electron cyclotron heating; FIR system; transient transport; internal turbulence; edge turbulence; ion temperature; EML experiments; impurity pellet experiments; MHD experiments and analysis; TEXT Upgrade; and Upgrade diagnostics.

33812 (DOE/S–0074) **Accelerator production of tritium (APT).** USDOE Energy Research Advisory Board, Washington, DC (USA). Feb 1990. 51p. Sponsored by U.S. DOE Office of the Secretary. Order Number DE90011195. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Energy Research Advisory Board has evaluated the current status of accelerator and related tritium-target technology to determine how soon and at what cost such a system could meet national tritium production needs. The Board found that an accelerator production of tritium (APT) system is an attractive option in terms of safety, environmental impact, and public acceptance. The highest safety and environmental risk is associated with the target-processing facility. This risk, however, is no greater than the risk associated with the tritium extraction facilities for the new production reactors that the Department plans to acquire. The Board chose the radio-frequency, continuous wave linear accelerator as the most suitable accelerator technology to use in evaluating the

APT concept. The Board found that this approach is technically sound. A strong program of research, development, and testing, particularly on the target system, is necessary to translate the technology into an operational facility. However, insurmountable problems during this process are not expected. The Board has described a program that provides for an APT facility in the shortest possible time. It may be possible to complete this program 10 years after contractor selection. However, the schedule is aggressive in that many activities are undertaken simultaneously, especially in the first four years, and technological and programmatic uncertainties exist that could extend the schedule and increase the overall cost appreciably. Large contingencies have been incorporated into a cost estimate to allow for the considerable uncertainty associated with technologies that are in such an early stage of development.

33813 (EGG-M–89060) **Current US efforts in fusion failure experience data.** Cadwallader, L.C. EG and G Idaho, Inc., Idaho Falls, ID (USA). 6 Apr 1989. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC07-76ID01570. (CONF-8904159–5: International Atomic Energy Agency fusion reactor safety meeting, Jackson, WY (USA), 4-7 Apr 1989). Order Number DE90010917. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report describes the current efforts of the Fusion Safety Program (FSP) at the Idaho National Engineering Laboratory (INEL) to collect, analyze, and use fusion-specific component failure data for safety work and to support design groups. The current practices regarding what course to take when no fusion-specific data exists are also discussed. 22 refs., 4 figs., 1 tab.

33814 (FRCEA-R–44) **Controlled thermonuclear reactions and Tora Supra program.** Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee. 1988. 31p. (In French). Order Number DE90792885. Available from NTIS (US Sales Only), PC A03/MF A01.

The research programs for the nuclear energy production by means of thermonuclear fusion are shown. TORA SUPRA, Joint European Torus, Next European Torus and those developed at the Atomic Energy Center are described. The controlled fusion necessary conditions, the energy and confinement balance, and the research of a better tokamak configuration are discussed. A description of TORA SUPRA, the ways of achieving the project and the expected delays are shown. The Controlled Fusion Research Department functions, concerning these programs, are described. The importance of international cooperation and the perspectives about the use of controlled fusion are underlined.

33815 (IC–89/144) **Temporal behaviour of self generated magnetic field and its influence on inhibition of thermal flux in ICF plasma.** Jha, L.N. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 12p. Order Number DE90627478. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The self generated magnetic field of megagauss order is reported to play a crucial role in ICF target designs because of its strong influence on the transport of energy from the critical density region to the ablation layer. The inhibition of the thermal flux due to such a field, thus, affects the whole of the other phenomenon of ICF. The knowledge of the proper variation of the magnetic field may help in assigning the existing controversial value of flux limit, f. Many papers dealing with the spatial variation of such a field exist and are well documented but the study on the variation of self generated field with time is rare. Here, the spatial variation of the megagauss field generated in the corona of a wire target irradiated by a laser as well as a model to study the temporal nature of the B-field at the peak have been obtained by solving the self inhibited diffusion which is regarded as the most dominant mechanism by which the thermal transport is influenced. The field exists for about ten nanoseconds even after the laser is switched off. The ratio of the two components of the thermal conductivity is also plotted against time and shows the inhibition. So, a track on the B-field variation both in space and time is necessary to keep for at least a few nanoseconds for computation of f. (author). 19 refs, 4 figs.

33816 (IC–89/164) **A review of self generated B-field in ICF corona.** Jha, L.N. International Centre for Theoretical Physics, Trieste (Italy). Jul 1989. 21p. Order Number DE90627479. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Self generated high order magnetic field in the corona of Inertial Confinement Fusion Plasma plays a very important role in the design of fusion target because of its strong influence on the transport of thermal flux from the critical density region to the ablation layer. A review of the generation of megagauss magnetic field both experimental, theoretical and simulation studies has been presented. (author). 28 refs, 5 figs, 1 tab.

33817 (IPPCZ–293/II, pp. 110-116) **Investigation of ion implosion on the thermonuclear facility SOWA-400.** Gryzinski, M. (Institute for Nuclear Studies, Otwock-Swierk (Poland)); Komar, V.; Stanislawski, J. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (In Russian). (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 2.* Order Number DE90627357. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

The interaction between focused high-energy ion flows and a dense gas target was studied on the SOWA-400 experimental facility. The high-energy ions are generated by a high-current gas discharge between two coaxial cylindrical electrodes made of parallel molybdenum rods. The working gas is let in by means of two electromagnetic fast ring valves located at both faces of the electrode system. The target gas cloud is created by two high-pressure electromagnetic valves mounted symmetrically at the chamber axis. The dynamics of the generated plasma was investigated using various visible and soft X radiation diagnostic methods. A good focusation of ions at the chamber axis was demonstrated. The mean energy of the observed X radiation was estimated to be about 1 keV. (J.U.). 6 figs., 3 refs.

33818 (IPP–III/153) **Sputtering flux measurements in the ASDEX divertor.** Fussmann, G.; Hofmann, J.V.; Janeschitz, G.; Yang, H.R. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Oct 1989. 43p. Order Number DE90792228. Available from NTIS (US Sales Only), PC A03/MF A01.

Eroded copper fluxes from the target plates in the ASDEX divertor were measured spectroscopically. The measuring method is outlined and comprehensive experimental material for various modes of tokamak operation is presented. Assuming thermal sputtering to be the only erosion process, we find good agreement between code predictions and the measurements. (orig.).

33819 (KEK–89-14, pp. 4-15) **Multi-laser beam accelerator.** Sugihara, Ryo (Nagoya Univ. (Japan). Plasma Science Center). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Oct 1989. (CONF-8908213–: Workshop on role of plasmas in accelerators, Tsukuba (Japan), 21 Aug 1989). In *Proceedings of the workshop on role of plasmas in accelerators.* Order Number DE90759999. Available from NTIS (US Sales Only), PC A06/MF A01.

A new scheme of particle acceleration is proposed in which an electron (or a positron) can coherently interact with a system of multi-laser beams. The system can trap and accelerate the particle obliquely to the direction of the beams, the principle being analogous to V_pxB or the cross field acceleration. It is demonstrated that if the electric field of an individual laser beam is 4×10^9 V/cm we may have a beam of 1 TeV electrons in a 100 m long device with a static magnetic field less than 20 kG. (author).

33820 (LA–11808-C) **US-Japan workshop on field-reversed configurations with steady-state high-temperature fusion plasmas and the 11th US-Japan workshop on compact toroids.** Barnes, D.C.; Fernandez, J.C.; Rej, D.J. (comps.). Los Alamos National Lab., NM (USA). May 1990. 220p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-8911130–: 11. US/Japan workshop on field-reversed configurations and compact toroids, Los Alamos, NM (USA), 7-9 Nov 1989). Order Number DE90010253. Available from NTIS, PC A11/MF A01; OSTI; INIS; GPO Dep.

The US-Japan Workshop on Field-Reversed Configurations with Steady-State High-Temperature Fusion Plasma and the 11th US-Japan Workshop on Compact Toroids were held at Los Alamos National Laboratory, Los Alamos, New Mexico on November 7–9, 1989. These proceedings contain the papers presented at the workshops as submitted by the authors. These papers have been indexed separately.

33821 (LRP–352/88) **Controlled thermonuclear fusion: research on magnetic fusion: Experimental hall and remotely operated manipulators. Concept of a reactor, and his environmental impact.** Paris, P.J. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)). Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Dec 1988. 47p. (In French). Order Number DE90627475. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Recent progress in thermonuclear fusion research indicates that the scientists' schedule for the demonstration of the scientific feasibility will be kept and that break-even will be attained in the course of the next decade. To see the implementation of ignition, however, the generation of future experiments must be awaited. These projects are currently under study. With technological research going on in parallel, they should at the same time contribute to the design of a reactor. Fusion reactors will be quite different from the fission nuclear reactors we know, and the waste of the plants will also be of a different nature. It is still too early to define the precise design of a fusion reactor. On the basis of a toric machine concept like that of the tokamak, we can, however, envisage that the problems with which we are confronted will be solved one after the other. As we have just seen, these will be the objectives of the future experimental installations where ignition will be possible and where the flux of fast neutrons will be so strong that they will allow the study of low-activation materials which will be used in the structure of the reactor. But this is also a task in which from now onwards numerous laboratories in Europe and in the world participate. The works are in fact punctiform, and often the mutual incidences can only be determined by an approach simulated by numerical codes. (author) 19 figs., 6 tabs., 8 refs.

33822 (SAND–89-2405) **Modeling of runaway electron damage for the design of tokamak plasma facing components.** Niemer, K.A. (North Carolina State Univ., Raleigh, NC (USA). Dept. of Nuclear Engineering); Gilligan, J.G.; Croessmann, C.D.; Bolt, H.H. Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. (CONF-891007–119: 13. IEEE symposium on fusion engineering, Knoxville, TN (USA), 2-6 Oct 1989). Order Number DE90008237. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Cracking, craters, spotty damage (discoloration), and missing chunks of material have been observed on limiters and along the midplane of tokamak inner walls. This damage is assumed to be due to runaway electron discharges. These runaway electrons have been predicted to range in energy from a few MeV to several hundred MeV. The energy density from the runaway electron discharges ranges from 10 to 500 MJ/m^2 over pulse lengths of 5 to 50 msec. The PTA code package is a three dimensional, time dependent, computational code package used to predict energy deposition, temperature rise, and damage on tokamak first wall and limiter materials form runaway electron impact. Two experiments were modeled to validate the PTA code package. The first experiment tested the thermal and structural response from high energy electron impact on different fusion materials, and the second experiment simulated runaway electrons scattering through a plasma facing surface (graphite) into an internal structure (copper). The PTA calculations compared favorably with the experimental results. In particular, the PTA models identified gap conductance, thermal contact, x-ray generation in materials, and the placement of high stopping power materials as key factors in the design of plasma facing components, resistant to runaway electron damage. 9 refs., 7 figs.

33823 (UCID–21849-Rev.1) **Electrical power from Inertial Confinement Fusion: Issues and prospects: Revision 1.** Tobin, M.T. (Lawrence Livermore National Lab., CA (USA)); Pitts, J.H.; Orth, C.D.; Moir, R.W.; Hogan, W.J.; Bangerter, R.O.; Meier, W.R. Lawrence Livermore National Lab., CA (USA). Mar 1990. 20p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010332. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report discusses the following topics on using inertial confinement for electrical power generation: general economic issues; design of reactors; safety and environmental issues; and development issues.

33824 (UCRL-ID–103486) **Microwave Tokamak Experiment: Overview and status.** Lawrence Livermore National Lab., CA (USA). May 1990. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. Order Number DE90010287. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Microwave Tokamak Experiment, now under construction at the Laboratory, will use microwave heating from a free-electron laser. The intense microwave pulses will be injected into the tokamak to realize several goals, including a demonstration of the effects of localized heat deposition within magnetically confined plasma, a better understanding of energy confinement in tokamaks, and use of the new free-electron laser technology for plasma heating. 3 figs., 3 tabs.

33825 (UTNL-R–239) **Proceedings of the 2nd Yayoi workshop on fusion reactor engineering.** Tokyo Univ., Tokai, Ibaraki (Japan). Nuclear Engineering Research Lab. Oct 1989. 142p. (In Japanese). (CONF-8905315–: 2. Yayoi workshop on fusion reactor engineering, Tokyo (Japan), 8-9 May 1989). Order Number DE90791319. Available from NTIS (US Sales Only), PC A07/MF A01.

This workshop was held on May 8-9, 1989 in University of Tokyo. The special lecture on the nuclear fusion research in Japan Atomic Energy Research Institute was given. The main topics were as follows. The interaction of plasma and walls, fuel dynamics, the research and development of high heat flux machinery and equipment, the electromagnetic phenomena in first walls, nuclear design techniques and nuclear fusion neutron streaming, the research on refining and separation techniques for tritium, the research on breeding and recovery of tritium, the behavior of neutrons and tritium formation in blankets, the research on liquid metal cooling, and high performance blankets. The second special lecture on the course of nuclear fusion research in universities was given. Other topics were the research on neutron irradiation, the development of nonmetallic materials, the research and development of ITER and reactor engineering, JT-60U project, the medical and biological effect of tritium, the utilization of neutrons, the safety of nuclear fusion reactors, and the research on the first wall of nuclear fusion reactors. (K.I.).

33826 **A model for the optically triggered pseudo-spark thyratron using local field and beam-bulk methods.** Pak, H. (Univ. of Illinois, Dept. of Electrical and Computer Engineering, Gaseous Electronics Lab, Champaign, IL (US)); Kushner, M.J. 64-71 of Pulse power for lasers II. Burkes, T.R.; McDuff, G. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). (CONF-8901155–: 2. pulse power for lasers, Los Angeles, CA (USA), 19-20 Jan 1989).

The optically triggered psuedo-spark, also known as the back-lit-thyratron (BLT), is a low pressure plasma switch having an unheated metallic cathode. In this paper, a computer simulation of the BLT is presented consisting of a 2-1/2 dimensional time dependent continuum model for electron and ion transport. The model utilizes both the local field approximation and a beam component for the electron distribution function. The authors find that switch closure depends critically on the formation of a virtual anode in front of the cathode hole by generation of positive space charge.

33827 **Pulse power considerations for the generation of 45 μs, 200 keV electron beams for CO_2 lasers.** Curry, R.D. (Pulse Sciences, Inc., San Leandro, CA (US)); Champney, P.; Demeter, L.; Lyons, S.; Morton, D.; Nishimoto, H.; Sears, R.; Schlitt, L.; Weseloh, W. 121-135 of Pulse power for lasers II. Burkes, T.R.; McDuff, G. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). (CONF-8901155–: 2. pulse power for lasers, Los Angeles, CA (USA), 19-20 Jan 1989).

A two module electron beam source operating over a wide range of output parameters has been designed and fabricated to be used in conjunction with a pair of electron beam sustained CO_2 lasers. Each module comprised a grid-controlled thermionic electron beam gun including a compact grid pulser for control of the electron beam, a 250 kV thyratron switched modulator for acceleration of the electron beam, a 1 kHz filament heater and a complex computerized control system. The system was designed to reliably produce 45 μs wide electron pulses of 150-200 keV energy, operate at repetition rates of 1-10 pps and current densities of 5-20 mA/cm^2. Additional parameters are listed. The high voltage cathode assembly employs 132 thoriated tungsten filaments distributed over the area of the 250 cm x 10 cm output window. The cathode assembly including the control grids is supported by two high voltage ceramic bushings in a stainless steel vacuum chamber. For acceleration of the electron beam, a pulsed 150-250 kV voltage is applied by a thyratron switched modulator, between the cathode and anode window. The fiber optically controlled grid pulser located in the modulator tank is floated at the applied cathode potential.

33828 Electron beam induced emission from carbon plasmas. Whetstone, S. (The Univ. of Michigan, Dept. of Nuclear Engineering, Cooley Building, North Campus, Ann Arbor, MI (US)); Kammash, T. 233-241 of Metal vapor, deep blue, and ultraviolet lasers. Kim, J.J.; Kimball, R.; Wisoff, P.J. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). (CONF-890166–: Conference on metal vapor, deep blue, and ultraviolet lasers technology and applications, Los Angeles, CA (USA), 17-20 Jan 1989).

Plasma use as a lasing medium has many potential advantages over conventional techniques including increased power levels and greater wavelength ranges. The basic concept is to heat and then rapidly cool a plasma forcing inversion through bottleneck creation between the recombination reaction populating a given energy level and the subsequent decay processes. Much effort has been devoted to plasmas heated by lasers and pinch devices. The authors are concerned here with electron beam heated plasmas focusing on the CIV 5g-4f transition occurring at 2530 Angstroms. These studies were initiated to provide theoretical support for experiments being performed at the University of Michigan using the Michigan Electron Long-Pulse Beam Accelerator (MELBA).

33829 Laser-triggered gas switch improvements on PBFA-II. Wilson, J.M. (Division 1266, Sandia National Lab., Albuquerque, NM (US)); Donovan, G.L. 361-364 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B. H.; Turchi, P. J. IEEE Service Center, Piscataway, NJ (USA) (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

PBFA-II is a thirty-six module ion accelerator built by Sandia National Laboratories for inertial confinement fusion feasibility studies. In the water-filled, pulse-forming section of the accelerator, each module is fitted with a 5.0 MV, SF_6-filled gas switch located between an intermediate storage capacitor and the first pulse-forming line. In recent experiments on PBFA-II, gas switches have been modified and tested at different gas pressures and voltages. These modifications are described in this paper.

33830 Smooth plasma-sheath transition in a hydrodynamic model–. Godyak, V.A. (GE Labs. Inc., Waltham, MA (US)); Sternberg, N. *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA),* 18(1): 159-168 (Feb 1990).

In the hydrodynamic plasma and sheath models, when the two models are treated separately the use of Bohm's criterion to obtain boundary conditions at the plasma-sheath interface leads to singularities and discontinuities in some physical quantities. The authors discuss how this problem can be overcome by using an appropriate boundary condition; namely, by specifying a particular finite value of the electric field at the plasma-sheath interface. Using such a boundary condition and arbitrary collision parameters, sheath characteristics are then calculated continuously from the collisionless to the collisional sheath. When applied to the plasma model, this new boundary condition takes into account the space-charge effect on the behavior of the plasma at its boundary.

33831 Cathode erosion rates in vacuum-arc discharges–. Brown, I.G. (Lawrence Berkeley Lab., CA (USA)); Shiraishi, H. *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA),* 18(1): 170-171 (Feb 1990). DOE Contract AC03-76SF00098. Contract NOOO14-18-F-0093.

Erosion rates of metal-vapor vacuum-arc cathode materials have been measured for a number of different cathode elements. The measured rates are compared with the rates predicted by a simple estimate based on the known ion generation rates. The agreement is good for the more refractory metals, while for the low boiling point metals there is evidence for an additional mass loss as, for example, might be associated with an intense macropractice generation.

33832 Plasma turbulence. Similon, P.L. (Applied Physics, Yale Univ., New Haven, CT (US)); Sudan, R.N. *Annual Review of Fluid Mechanics (USA),* 22: 317-348 (1990). Contract N000014-85-K-0212.

This paper presents an overview of the progress made in understanding plasma turbulence. It has relied heavily on numerical simulations to gain some intuition on the physical processes underlying nonlinear interaction and as a cross check for quantitative estimates derived from weak turbulence theory or DIA-based strong turbulence theory. The mathematical description of plasmas, especially those confined in a magnetic bottle, is far more complex than the Navier-Stokes fluid. Yet because of the dispersion of the plasma eigenmodes, the DIA perhaps has greater validity in a plasma than in a Navier-Stokes fluid. Recent developments in dynamical-systems theory have not yet been implemented in plasma turbulence at the level discussed in other studies for boundary-layer turbulence. This technique has promise for evaluating the behavior of large eddies, which may dominate plasma transport as a low-order system. In the collisionless, kinetic regime, where turbulence in x, v phase space has to be addressed, the new methods involving noneigenmode entities called clumps and holes, need further evolution to gain complete acceptability. For the future, a combination of analytical tools and numerical methods may afford the optimum route. Some examples of this are revireviewed.

33833 Multiple arc ion sources for heavy ion fusion. Rutkowski, H.L. (Lawrence Berkeley Laboratory, 1 Cyclotron Road, Berkeley, California 94720 (US)); Johnson, R.M.; Greenway, W.G.; Gross, M.A.; Hewett, D.W.; Humphries, S. Jr. *Review of Scientific Instruments (USA),* 61(1): 553-555 (Jan 1990). DOE Contract AC03-76SF00098. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

Heavy ion fusion requires high current density, low-emittance ion sources that are reliable and long lived. We report experimental and simulation results on the performance of carbon arc ion sources intended for use in a scaled induction linac experiment. These sources use a planar electrostatic plasma switch to prevent plasma from entering the extraction gap before the extraction voltage pulse is applied. This provides good beam optics for short pulse extraction. Measurements of current density and emittance are presented. Both double-slit and channel plate-pepper pot techniques are used for emittance measurement. Data presented are from a compact three-arc source with plasma coupling of the cathodes. Data on lifetime and multiple arc triggering are also presented. The plasma switch performance has been modeled with a 2D explicit electrostatic particle-in-cell code. Results showing plasma shutoff phenomena and behavior during extraction are presented. A 2D steady-state ion flow model is also used to predict the optimum plasma switch geometry for producing minimum emittance generation at the switch surface.

33834 Experimental simulation of a gaseous plasma collector. Fiksel, G. (Department of Nuclear Engineering— Department of Engineering Physics, University of Wisconsin-Madison, Madison, Wisconsin 53706-1687 (USA)); Kishinevsky, M.; Hershkowitz, N. *Physics of Fluids B (USA),* 2(4): 837-841 (Apr 1990). DOE Contract FG02-88ER53264.

Hydrogen plasma with a density of 3×10^{14} cm^{-3} and electron temperature of 20 eV is injected parallel to a 0.1 T B field, into hydrogen (and helium) neutral gas at 0.1–2 Torr. This plasma is opaque to molecular hydrogen but transparent to Franck–Condon neutrals. The axial density and temperature scale length increased

with decreasing gas pressure but were insensitive to plasma density and axial magnetic field strength. The plasma decay is explained by radial ion diffusion resulting from collisions with fast neutrals while the fast neutral density is determined by the radial pressure balance between fast neutrals and the cold background gas.

99 GENERAL AND MISCELLANEOUS

33835 (UJV–8731-V) **Main tasks of the Nuclear Research Institute in the period till the year 2000: Preliminary version.** Podest, M. (ed.). Ustav Jaderneho Vyzkumu CSKAE, Rez (Czechoslovakia). Jun 1989. 31p. (In Czech). Order Number DE90628335. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

VP VTR study.

The main tasks of the Nuclear Research Institute will be oriented to: safety of nuclear power installations; expert and diagnostic systems for such installations; the effect of operating medium on the life of nuclear power plants; disposal of radioactive wastes; prospective nuclear sources; research into and development of radiopharmaceuticals; radiation technologies and methods. Specific tasks are itemized. The statute of the Institute is attached. (J.B.). 1 tab.

9901 Management

Refer also to citation(s) 32528, 32965, 32983, 33855, 33858

33836 (DOE/MA–0411) **Guide for technical analysis of cost proposals for acquisition contracts.** USDOE Office of Procurement and Assistance Management, Washington, DC (USA). Office of Policy. May 1990. 18p. Sponsored by U.S. DOE Management & Administration. Order Number DE90010292. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of this guide is to enhance the quality of the technical analyses of cost proposals that are provided to the contracting officer. In using this guide, it must be recognized that the Department of Energy (DOE) is involved with funding a wide variety of projects. The products and services acquired vary greatly in complexity ranging from replenishing routine supplies, to acquiring support services, hardware, and to designing and constructing complex one-of-a-kind facilities. The requirements for technical analyses of cost proposals will also vary widely in both scope and requisite level of detail, depending on the supplies and services being acquired, the extent of competition, contractual instrument, and the type of proposer.

33837 (DOE/MA–0412) **Guide for technical analysis of budget proposals for financial assistance.** USDOE Office of Procurement and Assistance Management, Washington, DC (USA). Office of Policy. May 1990. 17p. Sponsored by U.S. DOE Management & Administration. Order Number DE90010291. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This guide covers the role of program/project office personnel in the budget (or cost) analysis of an applicant's financial assistance proposal. In using this guide, it must be recognized that the financial assistance activities of the Department of Energy (DOE) support a wide variety of programmatic activities and projects under a wide array of circumstances. In authorizing individual financial assistance programs of DOE, Congress has added, in many cases, specific unique requirements covering the eligibility and/or selection process, the award process, award amounts, and administration procedures. Consequently, the requirements for a cost analysis and the extent of technical input on the adequacy and reasonableness of a budget proposal may also vary; in both scope and requisite level of detail reflecting the differences not only in the types of recipients and the nature of the activity to be supported, but also in the requirements placed on the programs. The ultimate objectives in conducting technical budget analysis are to assure that the proposed amount of DOE (and recipient's) funding is adequate to achieve the intended purpose and that DOE funds will be expended in a manner that best effectuates the purposes of the program.

33838 (EGG–10617-1081) **Unifying the object-oriented paradigm with semantic data models.** Baltz, D.W. (EG and G Energy Measurements, Inc., Las Vegas, NV (USA)); Nartker, T.; Taghva, K. EG and G Energy Measurements, Inc., Las Vegas, NV (USA). [1990]. 24p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-88NV10617. (CONF-900781–2: 7. international conference on systems engineering; 11. structured development forum, Las Vegas, NV (USA); San Diego, CA (USA), 18-20 Jul 1990; 30 apr - 3 may 1990; CONF-9004191–1). Order Number DE90010840. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The object-oriented paradigm can be used to model behavior, and to a lesser extent, the structure of a problem domain. Semantic data models describe structure and semantics. This paper unifies the behavioral focus of the object-oriented paradigm with the structural and semantic focus of semantic data models. It presents abstractions to model static and derived data, composite objects, part hierarchies, semantic constraints, and abstractions for identifying behavior. The abstractions keep the model close to the problem domain, are independent of language features, and can be translated into object-oriented, relational or network implementations. This paper makes three principal contributions. First, a comprehensive set of data structuring abstractions is described. Second, semantic constraints inherent in the graphical representation of the abstractions are identified. Third, abstractions for identifying behavior are described. 14 refs., 17 figs.

33839 **FAO/IAEA research and training in soil fertility at the IAEA's Seibersdorf Laboratories.** Zapata, F. (International Atomic Energy Agency, Seibersdorf (Austria). Laboratories); Hardarson, G. *International Atomic Energy Agency Bulletin (Austria)*, 31(4): 55-60 (1989).

The Soil Science Unit of the Agency's Seibersdorf Laboratories provides invaluable research and development support for the co-ordinated research programmes and field technical co-operation projects co-ordinated by the soil fertility, irrigation, and crop production section of the Joint Division of the IAEA and FAO. This article describes how nuclear technology in soil and plant sciences is being developed and transferred through various mechanisms to help countries establish better conditions for crop and livestock production.

9902 Mathematics and Computers

Refer also to citation(s) 32119, 32134, 32191, 32235, 32237, 32261, 32290, 32298, 32324, 32341, 32342, 32343, 32356, 32358, 32359, 32360, 32361, 32362, 32363, 32369, 32417, 32418, 32422, 32423, 32424, 32430, 32431, 32496, 32497, 32503, 32548, 32612, 32636, 32701, 32792, 32843, 32844, 32845, 32848, 32852, 32855, 32856, 32857, 32861, 32873, 32876, 32877, 32881, 32883, 32886, 32887, 32939, 32949, 32981, 32992, 33021, 33022, 33033, 33036, 33038, 33039, 33110, 33168, 33279, 33361, 33388, 33596, 33631, 33858

33840 (CONF-900765–1) **Parallelizing the closure computation in automated deduction.** Slaney, J.K. (Australian National Univ., Canberra (Australia)); Lusk, E.L. Argonne National Lab., IL (USA). 22 Nov 1989. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Computer Aided Deduction Conference (CADE); Kaiserslautern (Germany, F.R.); 23-27 Jul 1990. Order Number DE90007792. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In this paper we present a parallel algorithm for computing the closure of a set under an operation. This particular type of computation appears in a variety of disguises, and has been used in automated theorem proving, abstract algebra, and formal logic. The algorithm we give here is particularly suited for shared-memory parallel computers, where it makes possible economies of space. Implementations of the algorithm in two application contexts are described and experimental results given. 12 refs., 3 figs., 2 tabs.

33841 (CONF-900793–1) **Skolem functions and equality in automated deduction.** McCune, W. Argonne National Lab., IL (USA). 6 Feb 1990. 14p. Sponsored by U.S. DOE Energy

Research. DOE Contract W-31109-ENG-38. From AAAI '90: 8. national conference on artificial intelligence; Boston, MA (USA); 29 Jul - 3 aug 1990. Order Number DE90009703. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We present a strategy for restricting the application of the inference rule paramodulation. The strategy applies to problems in first-order logic with equality and is designed to prevent paramodulation into subterms of Skolem expressions. A weak completeness result is presented (the functional reflexive axioms are assumed). Experimental results on problems in set theory, combinatory logic, Tarski geometry, and algebra show that the strategy can be useful when searching for refutations and when applying Knuth-Bendix completion. The emphasis of the paper is on the effectiveness of the strategy rather than on its completeness. 14 refs., 2 tabs.

33842 (CONF-9004159–7) **Visual animation of parallel algorithms for matrix computations.** Heath, M.T. Oak Ridge National Lab., TN (USA). [1990]. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 5. distributed memory computing conference; Charleston, SC (USA); 9-12 Apr 1990. Order Number DE90011076. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In this talk we show how graphical animation of the behavior of parallel algorithms can facilitate the design and performance enhancement of algorithms for matrix computations on parallel computer architectures. Using a portable instrumented communication library and a graphical animation package developed at Oak Ridge National Laboratory, we illustrate the effects of various strategies in parallel algorithm design, including interconnection topologies, global communication patterns, data mapping schemes, load balancing, and pipelining techniques for overlapping communication with computation. In this talk we focus on distributed-memory parallel architectures in which the processors communicate by passing messages. The linear algebra problems we consider include matrix factorization and the solution of triangular systems. 4 refs., 12 figs.

33843 (CONF-9006169–2) **Analysis of shared data structures for compile-time garbage collection in logic programs.** Mulkers, A. (Louvain Univ., Heverlee (Belgium). Dept. Computerwetenschappen); Bruynooghe, M.; Winsborough, W. Argonne National Lab., IL (USA). [1990]. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 7. international conference on logic programming; Jerusalem (Israel); 18-21 Jun 1990. Order Number DE90011117. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

One of the central problems in program analysis for compile-time garbage collection is detecting the sharing of term substructure that can occur during program execution. We present an abstract domain for representing possibly shared structures and an abstract unification operation based on this domain. When supplied to an abstract interpretation framework, this domain induces a powerful analysis of shared structures. We show that the analysis is sound by relating the abstract domain and operation to variants of the concrete domain and operation (substitutions with term unification) that are augmented with information about the term structures shared in actual implementations. We show these instrumented versions of the concrete domain and operation characterize the takes place in standard implementations. 22 refs., 3 figs.

33844 (DOE/ER/25026–35) **Potential performance of methods for parallelism across time in ODEs.** Xuhai, Xu; Gear, C.W. Illinois Univ., Urbana, IL (USA). Dept. of Computer Science. Jan 1990. 40p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract FG02-87ER25026. Contract DMS 87-03226. (UIUCDCS-R–90-1587;UILU-ENG–90-1726). Order Number DE90010992. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An earlier report described a possible approach to massive parallelism across time. This report describes some numerical experiments on the method and two modifications to the method to increase the parallelism and improve the behavior for nonlinear stiff problems.

33845 (EGG-EG–8893) **Computer-aided engineering annual report for calendar year 1989.** Brockelsby, H.C. Jr. EG and G Idaho, Inc., Idaho Falls, ID (USA). Mar 1990. 30p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90010979. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

During calendar year 1989, EG&G Idaho completed the initial procurement and implementation of a major new Computer-Aided Engineering (CAE) system. Seventy new workstations and associated engineering applications were installed over 100 personal computers (PCs) were integrated into the environment, and communications links to the IBM mainframes and the Cray supercomputer were established. The system achieves integration through sophisticated data communications and application interfaces that allow data sharing across the entire environment. Applications available on the system facilitate engineering relate to full three-dimensional (3-D) piping, heating/ventilating/air conditioning (HAVC), structural and steel design, solids modeling and analysis, desktop publishing, design and drafting, and include automated links to various analysis codes on the Cray supercomputer. The system also provides commonly used engineering tools such as spreadsheets, language compilers, terminal emulation, and file transfer facilities. Although difficult to quantify, recent information has shown that projected annual productivity improvement to the Idaho National Engineering Laboratory (INEL) will be in excess of $2,000,000. This improvement will be generated in a variety of areas including improvement in the efficiency of individual users, checkplot production, data management, file transfers, plotting. design-analysis interfaces, and the benefit of full 3-D design. Current plans call for a significant expansion of the CAE system in 1990 with continued expansion through 1993. Additional workstations, system software and utilities, networking facilities and applications software will be procured and implemented. More than one hundred people will receive training on the various application packages during 1990. Efforts to extend networking throughout the INEL will be continued. 2 refs.

33846 (JAERI-M–90-004) **CRUSH: a simplified computer program for impact analysis of radioactive material transport casks.** Ikushima, Takeshi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 58p. Order Number DE90791146. Available from NTIS (US Sales Only), PC A04/MF A01.

In drop impact analyses for radioactive shipping casks, it has become possible to perform them in detail by using interaction evaluation computer programs, such as DYNA2D, DYNA3D, PISCES and HONDO. However, the considerable cost and computer time are necessitated to perform such analyses by these computer programs. Therefore, simplified analysis computer programs which are capable of reducing cost and computer time are needed. To meet the above requirements, simplified computer program CRUSH has been developed. CRUSH is static calculation computer program capable of evaluating the maximum acceleration of the cask body and the maximum deformation of the shock absorber using the Uniaxial Displacement Method (UDM). In the paper, brief illstration of calculation method using UDM is presented. The second section presents comparisons between UDM and detailed method. The third section provides a user's input guide for CRUSH. (author).

33847 (JAERI-M–90-031) **CCS-I: a code to analyze a dynamic behavior of uranium enrichment process in a centrifuge cascade: An application to the safeguards effectiveness assessment.** Okamoto, Tsuyoshi (Tokyo Univ. (Japan)); Nishimura, Hideo. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 93p. Order Number DE90791168. Available from NTIS (US Sales Only), PC A05/MF A01.

CCS-I is a computer code for multiple purposes which can provide a designer of a uranium enrichment plant with the capabilities of analyzing performance of a centrifuge cascade and its dynamic behavior at a time of transient operations such as start-up and shut-down, of estimating inventory of UF_6 gas in the cascade and of examining various operational techniques to control the product enrichment of the cascade. Due to these functions, this code can be used for the effectiveness assessment of a safeguards system in such a way that it provides anomalies which the safeguards system should detect without any false decisions if a technique for producing uranium with higher enrichment than declared one is

used and that it suggests the frequency of inspections by estimating a time required to accumulate a significant amount of enriched uranium on a basis of enriching capability of the cascade. This report describes the modeling of a centrifuge cascade and the usage of the code for a dynamic simulation of the cascade with some examples in illustration. (author).

33848 (KCP–613-4215) **IPPEX [Inspection Process Planning EXpert]: An automated planning system for dimensional inspection.** Brown, C.W. Allied-Signal Aerospace Co., Kansas City, MO (USA). Kansas City Div. Apr 1990. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00613. (CONF-9006177–1: 22. International Institution for Production Engineering Research (CIRP) international seminar on manufacturing, Enschede (Netherlands), 11-12 Jun 1990). Order Number DE90010849. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper discusses recent accomplishments obtained from development efforts of a generative dimensional inspection planning system. This system, APEX (Inspection Process Planning EXpert), is a knowledge-based system, currently being developed for the dimensional inspection of piece parts. This prototype system applies artificial intelligence techniques and implements an advanced product definition modeling system. The APEX framework is based on a functional architecture designed for the purpose of producing CMM inspection plans, inspection part programs, and support information. The current APEX prototype system selects the appropriate CMM, identifies the measurable surfaces, suggests probing point determination, performs inspection work element planning, and creates an initial DMIS (Dimensional Measurement Interface Specification) part program, all for a specific workpiece. The following describes the APEX system, its functional activities, system architecture, product definition and tolerance representation, inspection features, inspection work elements, hierarchical inspection task planning approach, dimensional inspection techniques, part program creation, user interfaces formats, and other issues related to integrated inspection planning and part programming for CMMs. Finally, this paper describes a system that advances the development of automated inspection planning, product modelling systems with application accessible dimensions and tolerances, and standard dimensional inspection techniques and methodologies.

33849 (LA-UR–90-771) **Graph Structure Model.** Dreicer, J.S. Los Alamos National Lab., NM (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900781–1: 7. international conference on systems engineering, Las Vegas, NV (USA), 18-20 Jul 1990). Order Number DE90008945. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Graph Structure (GRPHSTRUC) Model is a software system tool specifically developed to be used by a computer security analyst to study the security and analyze the design of computer networks. However, any system that can be characterized and represented by a graph structure could employ GRPHSTRUC with some minor system modifications. The GRPHSTRUC model is a knowledge-based expert system using icons and object-oriented programming methodologies. GRPHSTRUC has been designed and developed to use classical graph theory and allow the display of components and links of a graph structure. A graph G = (V,E) is a structure that consists of a finite set of vertices V and a finite set of edges E. A computer network is a graph structure; the vertices are the components of the network and the edges are the links between components. The GRPHSTRUC model provides a user interface that is designed to give a user the ability to rapidly and efficiently represent graph components, connections, and relationships. 9 refs., 1 fig.

33850 (PB–90-166877/XAB) **Semantic correctness for a parallel object-oriented language.** Rutten, J.J.M.M. Centrum voor Wiskunde en Informatica, Amsterdam (Netherlands). c 1988. 49p. (CWI-CS-R–8843). Available from NTIS, PC A03/MF A01.

Different semantic models are studied for a language called POOL, a parallel object-oriented language. The paper relates both models, which are quite different, and proves the semantic correctness of the denotational semantics with respect to the operational semantics. The semantic investigations take place in the mathematical framework of complete metric spaces. Both the operational and the denotational semantics are reformulated and are presented, as well as many operators on the semantic domains, as the fixed point of a suitably defined contraction. In this way, the paper establishes a formal equivalence between both models. For this purpose, it introduces an intermediate domain, which first is compared to the operational model by means of an abstraction operator. This function takes processes, which are tree-like structures, as arguments and yields sets of streams as results. Next, it is shown that both the intermediate and the denotational model are fixed points of the same contraction, from which their equality follows. From both facts, the main result of the study follows: The operational meaning of a POOL program is equal to the denotational meaning to which the abstraction operator is applied. In this manner, the correctness of the denotational semantics with respect to the operational semantics is established.

33851 (PB–90-184714/XAB) **PCGPAK for message passing multiprocessors. Final report on Phase 1.** Baxter, D.J. Scientific Computing Associates, Inc., New Haven, CT (USA). Dec 1987. 25p. Available from NTIS, PC A03/MF A01.

See also PB–90-184755.

The goal of the Phase I work was the development of MP-PCGPAK, a subroutine package of iterative techniques for solving very large, sparse, nonsymmetric systems of linear equations in a message-passing multiprocessor supercomputer environment. MP-PCGPAK is based on PCGPAK, a state-of-the-art software tool for the iterative solution of linear systems on sequential-processing architectures. Since PCGPAK contains the iterative methods that are generally recognized as the best general-purpose sparse-matrix iterative methods, the objectives for Phase I were: to implement versions of the methods of PCGPAK, producing a preliminary version of MP-PCGPAK; to benchmark the message-passing version on realistic test problems; and to evaluate some reordered preconditioners for this architecture. Successful completion of these tasks has laid the foundation for the process of algorithm redesign and modification.

33852 (PB–90-184755/XAB) **Solving large sparse linear systems of equations in a global shared-memory multiprocessing environment. Final report on Phase 1.** Baxter, D.J. Scientific Computing Associates, Inc., New Haven, CT (USA). Sep 1987. 23p. Available from NTIS, PC A03/MF A01.

See also PB–90-184714.

The goal of the Phase I work was the development of SM-PCGPAK, a subroutine package of iterative techniques for solving very large, sparse, nonsymmetric systems of linear equations in a shared-memory multiprocessor supercomputer environment. SM-PCGPAK is based on PCGPAK, a state-of-the-art software tool for the iterative solution of linear systems on sequential-processing architectures. Since PCGPAK contains the iterative methods that are generally recognized as the best general-purpose sparse-matrix iterative methods, the objectives for Phase I were: to implement versions of the methods of PCGPAK, producing a preliminary version of SM-PCGPAK; to benchmark the shared-memory version on realistic test problems; and to evaluate some reordered preconditioners for this architecture. Successful completion of these tasks has laid the foundation for the process of algorithm redesign and modification.

33853 (SAND–90-0480C) **SEU characterization and design dependence of the SA3300 microprocessor.** Sexton, F.W.; Treece, R.K.; Axness, C.L.; Hughes, K.H.; Hash, G.L.; Hass, K.J. Sandia National Labs., Albuquerque, NM (USA). [1990]. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900723–9: 27. IEEE annual international nuclear and space radiation effects conference, Reno, NV (USA), 16-20 Jul 1990). Order Number DE90007678. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The SA3300 16-bit microprocessor is a key component for interplanetary space probes to be launched in the 1990's. A full SEU characterization of the D-latches of the SA3300 is given, including pattern sensitivity and temperature. 9 refs., 5 figs.

33854 (UCRL–102737-Rev.1) **POSC: A Partitioning and Optimizing SISAL Compiler: Revision 1.** Sarkar, V. (International Business Machines Corp., Yorktown Heights, NY (USA). Thomas J. Watson Research Center); Cann, D. Lawrence Livermore National Lab., CA (USA). Apr 1990. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-9006114–1-Rev.1: 4. ACM international conference on supercomputing, Amsterdam (Netherlands), 11-15 Jun 1990). Order Number DE90010679. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Single-assignment languages like SISAL offer parallelism at all levels — among arbitrary operations, conditionals, loop iterations, and function calls. All control data dependences are local, and can be easily determined from the program. Various studies of SISAL programs have that they contain massive amounts of potential parallelism. There are two major challenges in converting this potential parallelism into real speedup on multiprocessor systems. First, it is important to carefully select the useful parallelism in a SISAL program, so as to obtain good speedup by trading off parallelism with overhead. Second, it is important to do sequential optimizations, so that the sequential components (tasks) of the SISAL program have comparable execution times with sequential languages such as Fortran, Pascal and C. The POSC compiler system described in this paper addresses both issues by integrating previous work on efficient sequential implementation of SISAL programs with previous work on selecting the useful parallelism in a SISAL program. The combined approach is validated by real speedup measurements on a Sequent Balance multiprocessor. 30 refs., 1 tab.

33855 (UCRL-ID–103202) **Technical publication transfer test with Boeing Computer Services: MIL-M-28001 (SGML) and MIL-D-28000 Class I (IGES): Quick short test report.** Lawrence Livermore National Lab., CA (USA). 23 Mar 1990. 7p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CTN–90-0111). Order Number DE90010173. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This document is a short report of testing performed on Boeing Computer Services. Included are: test parameters, analysis, conclusions, and recommendations. (FSD)

33856 Using the multistage cube network topology in parallel supercomputers. Siegel, H.J. (Purdue Univ., Lafayette, IN (USA). School of Electrical Engineering); Nation, W.G.; Kruskal, C.P.; Napolitano, L.M. Jr. *Proceedings of the IEEE (Institute of Electrical and Electronics Engineers) (USA),* 77(12): 1932-1953 (Dec 1989). DOE Contract AC04-76DP00789. Grant F49620-86-K-0006.

A variety of approaches to designing the interconnection network to support communications among the processors and memories of supercomputers employing large-scale parallel processing have been proposed and/or implemented. These approaches are often based on the multistage cube topology. This topology is the subject of much ongoing research and study because of the ways in which the multistage cube can be used. The attributes of the topology that make it useful are described. These include O(N $\log_2$ N) cost for an N input/output network, decentralized control, a variety of implementation options, good data permuting capability to support single instruction stream/multiple data stream (SIMD) parallelism, good throughput to support multiple instruction stream/multiple data stream (MIMD) parallelism, and ability to be partitioned into independent subnetworks to support reconfigurable systems. Examples of existing systems that use multistage cube networks are overviewed. The multistage cube topology can be converted into a single-stage network by associating with each switch in the network a processor (and a memory). Properties of systems that use the multistage cube network in this way are also examined.

9903 Information Handling

Refer also to citation(s) 32205, 32416, 32467, 32529, 32551, 32931, 33388

33857 (AD-A–217408/4/XAB) **Natural language interfaces to data-base systems. Final report, April-August 1988.** Von Schweber, E.; Bordeaux, L.; Gowens, J.W. Georgia Inst. of Tech., Atlanta, GA (USA). Aug 1988. 83p. Available from NTIS, PC A05/MF A01.

Data-base management resulted from a need for data to be retained in the computer beyond the period of the current run. Since the earliest times of computer interaction, retrieving this data has been a significant problem. The motivation for this study was to look at the history of data base in order to critique the human computer interface with data bases and to project the next areas of research in data base management. A chronic consequence of man's normal condition of possessing incomplete knowledge of the detailed information to access and use that data is query failure. Although all query failure is frustrating, natural language failure can be especially insidious because it can fail by giving erroneous information to an unsuspecting user. Despite the current level of enthusiasm for natural language communication with the machine, this emulation of human-human communication may be the wrong approach to improving human-machine communication. A better approach may be to use methods of artificial intelligence such as semantic networks and object-oriented programming to create information sublanguages. Such a sublanguage would relieve the user of the need to have knowledge of data base metadata. Adaptive methods, flexible interaction, conceptual pattern matching and disambiguation methods paradigms that can be employed into a new (i.e. beyond relational) hybrid data base to strengthen the underlying structure of databases before communication with them can be improved. This paper provides suggestions on research directions in order to achieve that strengthened database structure.

33858 (DOE/TIC–11615) **Development of an Integrated Record Input System (IRIS) for DOE's Technical Information Center.** Cerny, B.A.; Lawrence, J.D.; Hammond, T.; Okseniuk, A.M. Lawrence Berkeley Lab., CA (USA). Nov 1982. 61p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (LBL–15723). Order Number DE83012853. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report describes the Integrated Record Input System (IRIS) that is being developed by the Lawrence Berkeley Laboratory to provide computer-assisted aids to document indexing for the Department of Energy's Technical Information Center Energy Information Data Base. Background and motivation and described, project scope and goals and given, and the software available in September 1982 in discussed in detail. An up-to-date user's manual is available as a companion report, User's Manual for the DOE Technical Information Center Computer-Assisted Indexing System, DOE/TIC-11616. 33 refs., 26 figs., 9 tabs.

33859 (DPST–87-891) **Analytical Data Management System (ADMS).** Kerrigan, W.J. Savannah River Lab., Aiken, SC (USA). 13 May 1987. 91p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90011248. Available from NTIS, PC A05/MF A01 - OSTI.

The current Analytical Development Division (ADD) Data Management System, (DMS) captures the essential analytical information during a sample analysis request using the DMS SAMPLE ANALYSIS REQUEST FORM. Analytical Development Division (ADD) personnel intercept each REQUEST FORM and assign appropriate Analysis Method Codes using the DMS ANALYSIS METHOD CODE ASSIGNMENT FORM. The SAMPLE ANALYSIS REQUEST FORM is "user-hostile" and first time users find it intimidating. Further, DMS operates on the unclassified IBM main frame (3081) using IBM's "Customer Information and Control System" (CICS). Sample submission, results entry, and all reporting functions are executed at night in batch mode. As a result of batch processing in the existing system, results and reports are not produced in a timely manner and neither ADD users nor ADD customers find it a "user-friendly" system. Increasing demands on the DMS and the constraints of the CICS environment and deficiencies in the existing DMS programming have led to the development of new DMS requirements. These requirements are discussed in this report.

33860 (PB–90-163221/XAB) **Semiannual Compilation of Project Briefs, February 1990 (Power Information Center).**

CSR, Inc., Washington, DC (USA). Power Information Center. Feb 1990. 64p. Available from NTIS, PC A04/MF A01.

See also PB–89-231567.

The Semiannual Compilation of Project Briefs represents a listing of the projects maintained in the Power Information Center (PIC) automated data base from August 1989 to January 1990. The information is presented in two categories. Part I is a listing by field of interest of the IAPG project briefs that are active or have been completed, cancelled, or closed out during the aforementioned time period. The fields of interest are chemical, electrical, magnetohydrodynamics, mechanical, nuclear, solar, and systems energy research. Part II is a subject index of the project briefs included in this issues.

33861 (PB–90-183161/XAB) **Defense Energy Information System (DEIS). Directive.** Carnes, J. Assistant Secretary of Defense (Production and Logistics), Washington, DC (USA). 2 Dec 1987. 7p. (DOD-D–5126.46). Available from NTIS, PC A02/MF A01.

The Directive reissues DoD Directive 5126.46, April 25, 1978; establishes the Defense Energy Information System (DEIS) and associated policy, procedures, and responsibilities for reporting and tracking energy-consumption data; charters the Defense Energy Data and Analysis Panel; cancels Defense Energy Program Policy Memorandums 80-13 (November 20, 1980), 84-2 (January 26, 1984), 84-4 (April 3, 1984), and 86-4 (April 24, 1986), and incorporates them in DoD 5126.46-M, which provides instructions for the preparation, submission, and use of energy data to support the DEIS; cancels Report Control Symbol DD-M(M)1313; and authorizes DoD publications such as manuals, regulations, and handbooks to supplement this Directive.

33862 (PB–90-863788/XAB) **Supervisory Control and Data Acquisition (SCADA). January 1975-December 1989 (A Bibliography from the COMPENDEX data base). Report for January 1975-December 1989.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 69p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning software, hardware, and implementation of Supervisory Control and Data Acquisition (SCADA) Systems. SCADA is applied to the control and monitoring of systems covering large geographical areas, such as electric power distribution, gas pipelines, water supply distribution, and offshore-platform operations. Topics include personnel training, man-machine interfaces, satellite communication links for SCADA, and networking technology. (Contains 137 citations fully indexed and including a title list.)

33863 (SAND–90-0869) **Sandia National Laboratories data engineering for DOE production agencies.** Hernandez, L. Jr.; Ellison, R.F. Jr.; Zubersky, J.L.; MacCosbe, G.L.; Davis, L.T. Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 77p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90010297. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

At Sandia National Laboratories data engineering is the application of both the art and science aspects of engineering principles to the acquisition and storage of product-related test and traceability data and to the transformation of this data into useful information through data retrieval and analysis processes. This report describes the application of data engineering to the data systems that have been developed in support of production agency built or procured product. The production agencies that are addresses in this report include Mason & Hanger, Amarillo, TX; GEND, Largo, FL, Allied Signal, KCD, Kansas City, MO; and Mount, Miamisburg, OH. Also discussed is the Weapon Evaluation Test Laboratory (7264)/ Amarillo. The scope of the data engineering program for each production agency (or test facility) is presented along with the interfaces and constraints. The present contractors' data system is described and system limitations and future plans are discussed. 7 refs., 38 figs.

Corporate Author Index

This index lists the corporate authors responsible for issuing the documents in this publication which are identified primarily by report number. The corporate names are entered in standardized forms as defined in *DOE Energy Data Base: Corporate Author Entries* (DOE/TIC-4585). Each entry under a corporate name includes the document title and citation number. Three items of information may appear in parentheses: (1) an abbreviation to identify the document type, such as a report; (2) the country of publication, also abbreviated; and (3) the language of the document if non-English (R;US;In French). Author affiliations are not listed in this index.

A

Acurex Corp., Jefferson, AR (USA)
Operations and research at the US EPA Incineration Research Facility: Annual report for FY89, 15:33089 (R;US)

Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France)
Energetic up-grading of wells in arterian basins, 15:32275 (R;FR;In French)
Maintenance and energy conservation - a pratical guide for energy managers and maintenance engineers, 15:32498 (R;FR;In French)
Solar powered pumping systems. Existing material, cost of a cubic meter, comparison with other pumping systems, maintenance, appendix, 15:32288 (R;FR;In French)
Wind potential energy determination at Cammazes site, 15:32301 (R;FR;In French)

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Aix-Marseille-1 Univ., 13 - Marseille (France)
Study of a liquid-vapour contact evaporator, 15:32868 (R;FR;In French)

Aix-Marseille-3 Univ., 13 - Marseille (France)
Amorphous GaAs thin layers, 15:32283 (R;FR;In French)

Allied-Signal Aerospace Co., Kansas City, MO (USA). Kansas City Div.
IPPEX [Inspection Process Planning EXpert]: An automated planning system for dimensional inspection, 15:33848 (R;US)

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Wake deficit measurements on the Jess and Souza Ranches, Altamont Pass, 15:32305 (R;US)

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Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 17, April 1–June 30, 1988, 15:32062 (R;US)
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 23, July 1–September 30, 1988, 15:32063 (R;US)
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 25, October 1–December 31, 1988, 15:32064 (R;US)
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 29, January 1–March 31, 1989, 15:32065 (R;US)
Production of jet fuels from coal derived liquids: Volume 6, Preliminary analysis of upgrading alternatives for the Great Plains liquid by-product streams: Interim report, March 1987–February 1988, 15:32058 (R;US)
Production of jet fuels from coal derived liquids: Volume 9, Results of bench-scale testing and pilot plant testing: Interim report, February 1988–March 1989, 15:32059 (R;US)

Applied Physics Technology, Inc., Great Falls, VA (USA)
Development of the oil-water monitor: Quarterly progress report No. 3, 15:33005 (R;US)

Applied Research Corp., Landover, MD (USA)
Positron Emission Tomography with improved spatial resolution: The ninth months technical report, 15:33213 (R;US)

Architectural Energy Corp., Boulder, CO (USA)
Lumen Day: A new concept for daylighting design in commercial buildings. Final report on Phase 1, 15:32486 (R;US)

Argonne National Lab., Idaho Falls, ID (USA)
Experiments and analysis for large conventional fast reactors in ZPPR-18/19, 15:32326 (R;US)

Argonne National Lab., IL (USA)
A summary of prospects for methanol vehicles in the United States, 15:32525 (R;US)
Analysis of shared data structures for compile-time garbage collection in logic programs, 15:33843 (R;US)
Calculation of free energy from the internal-energy distribution function, 15:33615 (R;US)
Cascade collapse in copper and nickel, 15:32540 (R;US)
Ceramic epitaxial films and multilayers prepared by MOCVD, 15:32606 (R;US)
Characterization of high damping bearings and their responses to earthquake motions, 15:32842 (R;US)
Circumfluous motion of a conductive liquid around solid objects in a magnetic field, 15:33607 (R;US)
Comparative three-dimensional flow analysis of MHD generators and seawater thrusters, 15:32473 (R;US)
Cumulative impact assessment: A case study, 15:32277 (R;US)
Desorption of H_2O and H_2 from steel and $LiAlO_2$ by temperature programmed desorption, 15:33805 (R;US)
Development of nondestructive evaluation methods and prediction of effects of flaws on the fracture behavior of structural ceramics, 15:32112 (R;US)
Effects of internal hydrogen on the vacancy loop formation probability in Al, 15:32539 (R;US)
Electromagnetic computations for fusion devices, 15:33731 (R;US)
Embrittlement of the Shippingport reactor neutron shield tank, 15:32321 (R;US)
Energy conservation program evaluation: Practical methods, useful results: Proceedings: Volume 2, August 20 and 21 sessions, 15:32479 (R;US)
High T_c oxide solid state reaction kinetics via complex impedance spectroscopy, 15:32802 (R;US)
Importance of weak hydrogen bonding C-H–donor and C-H–anion interactions in governing the structural properties of organic

donors BEDT-TTF and BEDO-TTF and their charge-transfer salts, 15:32803 (R;US)
In-situ growth of superconducting films of Bi-Sr-Ca-Cu-O using magnetron sputtering, 15:32604 (R;US)
JANUS neutron irradiation of a mouse cell line containing a shuttle vector plasmid, 15:33221 (R;US)
Multimedia assessment of health risks for the Weldon Spring site remedial action project, 15:32202 (R;US)
Parallelizing the closure computation in automated deduction, 15:33840 (R;US)
Parametric study of electrostatically charged sprays, 15:32862 (R;US)
Practical superconductor development for electrical power applications: Annual report for FY 1989, 15:32878 (R;US)
Rate constants for the reaction, $O + H_2O \rightarrow OH + OH$, over the temperature range, 1500–2400 K, by the flash photolysis-shock tube technique: A further consideration of the back reaction, 15:32781 (R;US)
Results of emissions and ash testing in full-scale co-combustion tests of binder-enhanced dRDF pellets and high-sulfur coal, 15:32513 (R;US)
Role of melting temperature on the properties of displacement cascades, 15:32541 (R;US)
Skolem functions and equality in automated deduction, 15:33841 (R;US)
Spectral characteristics of insertion device sources at the Advanced Photon Source, 15:32932 (R;US)
Sulfur species in perchloroethylene and other coal extracts, 15:32780 (R;US)
Superconducting thin films of YBaCu oxides prepared by MOCVD, 15:32607 (R;US)
Surveillance of Site A and Plot M report for 1989, 15:33137 (R;US)
Technical and economic evaluation of diesel engine with oxygen enrichment and water injection, 15:32502 (R;US)
Technology choice in a least-cost expansion analysis framework: The impact of gas prices, planning horizon, and system characteristics, 15:32318 (R;US)
The AFLC ECAMP [Environmental Compliance Assessment and Management Program] experience: How it was done and lessons learned, 15:32442 (R;US)
The Argonne Utility Simulation model: An analysis tool for evaluating energy and environmental strategies, 15:32097 (R;US)
The environmental compliance process at New York FUSRAP [Formerly Utilized Sites Remedial Action Program] sites, 15:32253 (R;US)
The measurement of gamma heating in a fusion blanket test assembly, 15:33804 (R;US)
Urban modeling of organic aerosol source emissions, 15:33047 (R;US)
X-ray absorption spectroscopy: EXAFS [Extended X-ray Absorption Fine Structure] and XANES [X-ray Absorption Near Edge Structure]: A versatile tool to study atomic and electronic structure of materials, 15:33327 (R;US)

Argonne National Lab., IL (USA). Advanced Photon Source Accelerator Systems Div.
Proceedings of the impedance and bunch instability workshop, 15:32919 (R;US)

Argonne National Lab., IL (USA). Energy Systems Div.
Magnetic heat pumps, 15:32499 (R;US)

Argonne National Lab., IL (USA). Environment, Safety, and Health Dept.
Radiological oversight and certification report for the Lansdowne property, 105-107 East Stratford Avenue, Lansdowne, Pennsylvania, August 1988–June 1989, 15:33114 (R;US)
Volume estimate of radium-contaminated soil in a section of Barrows Field Park, Glen Ridge, New Jersey, November–December 1989, 15:33115 (R;US)

Argonne National Lab., IL (USA). Environmental Assessment and Information Sciences Div.
Introduction to the Argonne Utility Simulation (ARGUS) model, 15:32470 (R;US)

Argonne National Lab., IL (USA). High Energy Physics Div.
Rad-hard electronics development program for SSC liquid-argon calorimeters, 15:32966 (R;US)
Radiation tolerance implications for the mechanical design of a scintillator calorimeter for the SSC, 15:32967 (R;US)

Argonne National Lab., Washington, DC (USA)
Emissions involved in acidic deposition processes: Methodology and results, 15:33048 (R;US)

Arizona State Univ., Tempe, AZ (USA)
Passive cooling, 15:32483 (B;US)

Arizona Univ., Tucson, AZ (USA). Dept. of Biochemistry
Chlorophyll photochemistry in microheterogeneous media, 15:32279 (R;US)

Assistant Secretary of Defense (Atomic Energy), Washington, DC (USA)
Military Liaison Committee to the Department of Energy. Directive, 15:33018 (R;US)

Assistant Secretary of Defense (Production and Logistics), Washington, DC (USA)
Defense Energy Information System (DEIS). Directive, 15:33861 (R;US)

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Controlled thermonuclear reactions and Tora Supra program, 15:33814 (R;FR;In French)

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Burn condition for fusion plasmas, helium particle confinement and exhaust efficiency, 15:33779 (R;DE)
Measurement of the internal magnetic field structure of tokamak plasmas, 15:33778 (R;DE;In German)

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Electron-probe microanalysis: x-ray spectroscopy, 15:32786 (R;FR;In French)

Atkins Oil and Gas Engineering Ltd., London (UK)
Sensitivity study of member stresses to current profile variations, 15:32132 (R;GB)

Australian National Univ., Canberra (Australia). Plasma Research Lab.
A novel scanning interferometer for two-dimensional plasma density measurements, 15:33730 (R;AU)
Papers presented at seventh international workshop on stellarators, 15:33802 (R;AU)

B

Battelle/Marine Sciences Lab., Sequim, WA (USA)
Concentrations of metals in Norton Sound seawater samples and human hair samples, 1989, 15:33188 (R;US)

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Surface acoustic wave (SAW) gas microsensor for SO_2. Final report, 15:33084 (R;US)

Bonn Univ. (Germany, F.R.)
The reaction anti pp $\rightarrow$ anti $\Lambda\Lambda$ 92 MeV above the reaction threshold, 15:33402 (R;DE;In German)

Bonn Univ. (Germany, F.R.). Mathematisch-Naturwissenschaftliche Fakultaet
Development of a large-area scintillation detector with good spatial resolution, 15:32968 (R;DE;In German)
Studies on the separation between higher-twist and minimum-twist in the photoproduction experiment WA69 at the CERN-OMEGA spectrometer, 15:33427 (R;DE;In German)
The calculation of the quark distribution amplitude of the $\Delta^{3/2+}(1232)$ respectively the $\Delta^{1/2-}(1600)$ by means of the QCD sum rules for the determination of the $N \rightarrow \Delta$ transition form factor at $Q^2 \simeq 10$ GeV^2, 15:33426 (R;DE;In German)

Bonn Univ. (Germany, F.R.). Physikalisches Inst.
Development of a large-area scintillation detector with good spatial resolution, 15:32968 (R;DE;In German)
Integrodifferential equation approach. Pt. 2. Triton and α-particle wave functions. Graphical plots, 15:33563 (R;DE)
Studies on the separation between higher-twist and minimum-twist in the photoproduction experiment WA69 at the CERN-OMEGA spectrometer, 15:33427 (R;DE;In German)

The calculation of the quark distribution amplitude of the $\Delta^{3/2+}(1232)$ respectively the $\Delta^{1/2-}(1600)$ by means of the QCD sum rules for the determination of the N→Δ transition form factor at $Q^2 \simeq 10$ GeV^2, 15:33426 (R;DE;In German)

Bouwcentrum, Rotterdam (Netherlands)
Passive use of solar energy in the public housing of Capelle aan den IJssel, Netherlands: Evaluation and final report, 15:32291 (R;NL;In Dutch)

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British Coal Corp., Stoke Orchard (UK). Coal Research Establishment
Reducing sulphur in coke, 15:32068 (R;XE)

British Steel Corp., London (UK)
Effect of blast furnace coal injection upon bosh coke properties, coke combustion and furnace permeability, 15:32117 (R;XE)

Brookhaven National Lab., Upton, NY (USA)
A perfluorocarbon tracer transport and dispersion experiment in the North Sea Ekofisk oil field: Revision, 15:33116 (R;US)
Biomass and hydrocarb technology for removal of atmospheric CO_2, 15:32266 (R;US)
Decontamination impacts on solidification and waste disposal, 15:32200 (R;US)
Encapsulation of mixed radioactive and hazardous waste contaminated incinerator ash in modified sulfur cement, 15:32199 (R;US)
Gallium a unique anti-resorptive agent in bone: Preclinical studies on its mechanisms of action, 15:33212 (R;US)
New challenges for HEP computing: RHIC [Relativistic Heavy Ion Collider] and CEBAF [Continuous Electron Beam Accelerator Facility], 15:32906 (R;US)
Nuclear engineering research opportunities at Brookhaven National Laboratories, 15:32462 (R;US)
Orbit calculations and lattice parameters for the BNL [Brookhaven National Laboratory] SXLS [Superconducting X-Ray Lithography Source]: Part 2, Betatron functions in the superconducting bending magnet and synchrotron radiation integrals, 15:32920 (R;US)
Physics of the pion liquid, 15:33562 (R;US)
Relativistic heavy ions from the BNL [Brookhaven National Laboratory] booster medical research and technological applications, 15:32907 (R;US)
Summary of construction details and test performance of recent series of 1.8 meter SSC dipoles at BNL, 15:32930 (R;US)
The magnet components database system, 15:32931 (R;US)

Brown Univ., Providence, RI (USA). Div. of Engineering
Cyclic damage zones ahead of tensile fatigue cracks in ceramic materials, 15:32608 (R;US)
Fatigue crack growth in ceramic materials at ambient and elevated temperatures, 15:32610 (R;US)

Building Research Establishment, Watford (UK)
Daylighting as a passive solar energy option: an assessment of its potential in non-domestic buildings, 15:32478 (R;GB)

Bundesforschungsanstalt fuer Landwirtschaft, Braunschweig (Germany, F.R.). Inst. fuer Betriebswirtschaft
Repercussion of the production of renewable resources on foodstuff supply and appraisal of policy measures for promoting the production of renewable resources, 15:32268 (R;DE;In German)

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Investigations on the detection and prevention of DNA-lesions induced by ionizing irradiation, 15:33220 (R;DE;In German)

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Repercussion of the production of renewable resources on foodstuff supply and appraisal of policy measures for promoting the production of renewable resources, 15:32268 (R;DE;In German)

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Wind tunnel tests on the evaluation of interferences due to buildings on the propagation of radioactive materials after release from nuclear facilities. Report and annex, 15:33046 (R;DE;In German)

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Molycorp Guadalupe Mountain tailings disposal facility. Final report, 15:33167 (R;US)

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Analyses of natural gases, 1917-1989. Data file, 15:32182 (R;US)

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Minerals yearbook, 1988. Molybdenum, 15:32458 (R;US)
Minerals yearbook, 1988. Rare-earth minerals and metals, 15:32461 (R;US)
Minerals yearbook, 1988. Tungsten, 15:32456 (R;US)
Minerals yearbook, 1988. Vanadium, 15:32459 (R;US)

C

Caen Univ., 14 (France)
Theoretical and experimental aspects of the multiple fragmentation reactions in the nucleus-nucleus collisions at intermediate energies, 15:33567 (R;FR;In French)

California Dept. of Food and Agriculture, Sacramento, CA (USA)
Monitoring for genetically engineered pseudomonas species in monterey county, 15:32282 (R;US)

California State Univ., Long Beach, CA (USA). Long Beach Foundation
Muonic molecular structure, μ-sticking probability and fusion rates for muon catalyzed fusion: Final technical report, 15:33720 (R;US)

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Physical modeling of bubble phenomena, electrolyte flow and mass transfer in simulated advanced Hall cells: Final report, 15:32504 (R;US)

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Development of an expert-system embedding pattern-recognition techniques for pollution-source identification. Report for 30 September 1987-29 November 1989, 15:33171 (R;US)

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Camborne geothermal energy project 2C-5. Final report Phase 2C: October 1986 - September 1988, 15:32296 (R;GB)

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Assessing UST corrective action technologies: Site assessment and selection of unsaturated zone treatment technologies. Report for October 1987-September 1989, 15:32159 (R;US)

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Economic impact study of landfill regulations (R88-7). Final report, 15:33165 (R;US)

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Major chemical accidents: Are we prepared?, 15:32443 (R;CA)

Carnegie-Mellon Univ., Pittsburgh, PA (USA). Dept. of Physics
Hadron physics: Summary papers on hadron physics for the NSAC long range plan, 15:33434 (R;US)

Catalytic Energy Corp., Arlington, VA (USA)
Development of a catalytic infrared cooking gas burner, 15:32178 (R;US)

CEA Centre d'Etudes de Bruyeres-le-Chatel, 91 (France)
Phase transition in a shock loaded 304 stainless steel, 15:32535 (R;FR;In French)
Photo-injector, accelerator chain and wiggler development programs for a high peak power RF-Free electron laser, 15:32921 (R;FR)

CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)
Optical coatings processed by CO2 laser sintering, 15:32532 (R;FR)

CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France)
Development of a new fluorometric detection test of sulfatoreducing bacteria type Desulfovibrio. Laboratory evaluation of chemical control of bacteria activity in biocorrosion, 15:32545 (R;FR;In French)
Investigation on U - O - Na, Pu - O - Na and U,Pu - O - Na phase diagrams, 15:32603 (R;FR;In French)
Mechanisms of ^{60}Co uptake and loss by Scenedesmus obliquus and transfer to two benthic organisms, 15:33138 (R;FR;In French)

Ressac program plants analytical experiments study of a code modelling the soil to plant transfer factor of cesium, 15:33117 (R;FR;In French)

CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)

Effect of environmental materials on R7T7 nuclear waste glass alteration. Clay effect, 15:32201 (R;FR;In French)

Study of axial mixing phenomena in pulse columns equipped with crown-disk packing, 15:32196 (R;FR;In French)

CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete

Prediction of the brittle-ductile transition temperature shift, from irradiation experiments obtained in France, 15:32533 (R;FR;In French)

CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection Sanitaire

Faster radiotoxicological analyses of alpha emitters, 15:32778 (R;FR;In French)

CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France)

Assessment of TRAC-PF1/MOD1 version 14.3 using separate effects critical flow and blowdown experiments: Volume 1, Test and tables, 15:32423 (R;US)

Assessment of TRAC-PF1/MOD1 Version 14.3 using separate effects critical flow and blowdown experiments: Volume 2, Figures, 15:32424 (R;US)

Effect of environmental materials on R7T7 nuclear waste glass alteration. Clay effect, 15:32201 (R;FR;In French)

CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Recherche Fondamentale

Adsorption in cryogenics, 15:32841 (R;FR;In French)

Fission product measurement methods. Present state of knowledge, 15:33565 (R;FR;In French)

Study of a magnetic refrigeration cycle by active regeneration between 15 and 4.2 kelvins, 15:32864 (R;FR;In French)

CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)

Detection limits for Gamma-Ray spectral analysis, 15:32969 (R;FR;In French)

CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Technologie

Heat treatments influence on mechanical properties of zircaloy 4 - particular study of fatigue structures, 15:32534 (R;FR;In French)

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Spin observables in antip-N elastic scattering, 15:33399 (R;FR)

CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Theorique

Cut-off and effective meson field theory, 15:33431 (R;FR)

CEA Etablissement de la Vallee du Rhone, 30 - Bagnols-sur-Ceze (France)

Effect of environmental materials on R7T7 nuclear waste glass alteration. Clay effect, 15:32201 (R;FR;In French)

Study of axial mixing phenomena in pulse columns equipped with crown-disk packing, 15:32196 (R;FR;In French)

CEA, 75 - Paris (France). Dept. des Programmes

Energy in China, 15:32471 (R;FR;In French)

Centers for Disease Control, Atlanta, GA (USA). Center for Environmental Health and Injury Control

Comparison of serum levels of 2,3,7,8-tetrachlorodibenzo-p-dioxin with indirect estimates of Agent Orange exposure among Vietnam veterans. Final report, 15:33235 (R;US)

Central Research Inst. of Electric Power Industry, Abiko, Chiba (Japan)

Biological effects of combined exposure to coal fly ash and nitrogen dioxide, 15:32122 (R;JP;In Japanese)

Central Research Inst. of Electric Power Industry, Tokyo (Japan)

Anthropogenic sulfur dioxide emission in Far East Asia, 15:32098 (R;JP;In Japanese)

Centre National de la Recherche Scientifique, 75 - Paris (France). Programme Interdisciplinaire de Recherche sur les Sciences pour l'Energie et les Matiernes Premieres (PRISEM)

Amorphous GaAs thin layers, 15:32283 (R;FR;In French)

Experimental determination of the flow speed of the Dogger geothermal aquifer in the Paris basin, 15:32294 (R;FR;In French)

Study of a liquid-vapour contact evaporator, 15:32868 (R;FR;In French)

Tin-water magnetohydrodynamic electric power generator, 15:32475 (R;FR;In French)

Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil)

A generalised Hubbard Hamiltonian: influence of temperature and fractality, 15:33610 (R;BR)

A higher-order analysis of the effects of breaking supersymmetry for non-linear σ-models, 15:33472 (R;BR)

An experimental study of the A-dependence of J/psi photoproduction, 15:33527 (R;BR)

Apple interface for experimental instrumentation and control-Pulse counter, timer, digital-to-analog converter, step motor and relays, 15:33004 (R;BR;In Portuguese)

Casimir effect in a d-dimensional flat spacetime and the cut-off method, 15:33665 (R;BR)

Criticality of the three-state chiral clock model: a renormalisation group study, 15:33609 (R;BR)

Definition of a multicentral bond index, 15:33326 (R;BR)

Dirac's equation as a geodesic in Riemann space, 15:33664 (R;BR)

Dynamical information for Fe doped $YBa_2Cu_3O_7$ superconducting oxides obtained from high temperature Moessbauer studies, 15:32602 (R;BR)

Effective fire-tube and geometric scaling in proton-proton and proton-antiproton collisions, 15:33564 (R;BR)

Effects of A1 substitution by Fe in $CeAl_2$, 15:32531 (R;BR)

Gauge transformations for six dimensional superfields, 15:33474 (R;BR)

Geometrical properties of an internal local octonionic space in a non-Riemannian manifold, 15:33662 (R;BR)

Hadron production in a fireball radiation model for electron-positron collisions, 15:33428 (R;BR)

Higher order equations of motion, 15:33430 (R;BR)

On BRST quantization of chiral bosonic particle, 15:33661 (R;BR)

On the ζ-function regularization of chiral Jacobians for singular Dirac operators, 15:33663 (R;BR)

Physical properties of the chiral quantum baryon, 15:33429 (R;BR)

Probability of ternary fission of ^{93}Nb and^{nat} Ag nuclei induced by 0.8-1.8 GeV photons, 15:33539 (R;BR)

Radiation-induced paramagnetic species in natural calcite speleothems, 15:33612 (R;BR)

S100 lathe bed pulse generator applied to pulsed nuclear magnetic resonance, 15:33003 (R;BR;In Portuguese)

Susceptibility of the Potts model in an hierarchical lattice: renormalisation group approach, 15:33613 (R;BR)

Systematic approach to critical phenomena by the extended variational method and coherent-anomaly method, 15:33608 (R;BR)

The stability of the classical Skyrme model SU(2) hedgehog soliton, 15:33475 (R;BR)

Torsion-induced gauge superfield mass generation for gauge-invariant non-linear σ-models, 15:33473 (R;BR)

Viscous causal cosmologies, 15:33284 (R;BR)

Z(6) model: criticality and break-collapse method, 15:33611 (R;BR)

Centro Tecnico Aeroespacial, Sao Jose dos Campos, SP (Brazil). Inst. de Estudos Avancados

Determination of calibration constants for perturbing objects of cavity resonators, 15:32879 (R;BR;In Portuguese)

Centrum voor Wiskunde en Informatica, Amsterdam (Netherlands)

Semantic correctness for a parallel object-oriented language, 15:33850 (R;NL)

Cermak Peterka Petersen, Inc., Fort Collins, CO (USA)

Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 1, Detailed report, 15:32137 (R;US)

Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 2, Figures and tables for the detailed report, 15:32138 (R;US)

Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 3, Appendices A–G, 15:32139 (R;US)

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Air pollution: National air monitoring network is inadequate, 15:33058 (R;US)
Drinking water: Safeguards are not preventing contamination from injected oil and gas wastes, 15:32153 (R;US)
Energy management: DOE has not shown systems contracting to be in government's best interest, 15:32464 (R;US)
Energy security: Analysis of studies on economic consequences of an oil import tariff, 15:32149 (R;US)
Federal research: Final site selection process for DOE's super collider, 15:32960 (R;US)
Fossil fuels: Status of DOE-funded clean coal technology projects as of March 19, 1989, 15:32043 (R;US)
Nuclear materials: Information on DOE's replacement tritium facility, 15:32194 (R;US)
Nuclear regulation: NRC's decommissioning procedures and criteria need to be strengthened, 15:32349 (R;US)
Nuclear regulation: NRC's restart actions appear reasonable-but criteria needed, 15:32365 (R;US)
Nuclear waste: Quaterly report as of March 21, 1989, 15:32219 (R;US)
Nuclear waste, 15:32220 (R;US)
Surface mining: Information of legal fees under the surface mining act, 15:32109 (R;US)
The coast guard's cleanup of hazardous waste sites, 15:33126 (R;US)

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Electric logging and electrical properties of rocks in Rainier Mesa area, Nevada Test Site, Nevada, 15:32717 (R;US)
Geologic map of the surficial deposits of the Yucca Flat area, Nye County, Nevada, 15:33278 (R;US)
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Calculation of positron spectra from heavy-ion collisions and study of the line structure, 15:33329 (R;DE;In German)
Correlated positron-electron emission in heavy-ion collisions at the Coulomb barrier, 15:33330 (R;DE)
Excitation-energy sharing in uranium induced dissipative collisions, 15:33540 (R;DE)
Fragment emission in the reaction $^{40}Ar+^{197}Au$ at E/A=30 and 220 MeV, 15:33552 (R;DE)
Relativistically covariant projection formalism for an interacting quantum field theory, 15:33484 (R;DE)
Report of the Expert Committee 'Intermediate-Energy Physics' 1986-1988/89, 15:33400 (R;DE;In German)
Supplement to the report of the Expert Committee 'Nuclear Physics and Heavy-Ion Research' 1986-1988/89, 15:33528 (R;DE;In German)
Supplement to the report of the Expert Committee 'Intermediate-Energy Physics' 1986-1988/89, 15:33401 (R;DE;In German)
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Theoretical and experimental aspects of the multiple fragmentation reactions in the nucleus-nucleus collisions at intermediate energies, 15:33567 (R;FR;In French)

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Tin-water magnetohydrodynamic electric power generator, 15:32475 (R;FR;In French)

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Anharmonicities of vibrational motion in even-even deformed nuclei, 15:33575 (R;FR)
Entropy and Effective temperature in second RPA dynamics, 15:33574 (R;FR)

News developments at Sara, 15:32908 (R;FR)

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Cancellation of infrared and mass singularities in the thermal dilepton rate, 15:33505 (R;FR)
Phenomenological study of the polarized lepto production, 15:33448 (R;FR)

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Development of a precise hadron calorimeter, 15:32971 (R;DE;In German)
Electron spectroscopic investigation of atomic 4d giant resonances for Ba, La and lanthanides, 15:33331 (R;DE;In German)

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The Weil-Petersson Kaehler form on the super Teichmueller space, 15:33478 (R;JP)

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3.5% cold leg break test without hydroaccumulator application: Computerized measurement analysis, 15:32375 (R;HU;In Hungarian)
Entropy content from strange particle ratios in the E802 experiment, 15:33445 (R;HU)
Entropy production in the relativistic heavy ion collisions, 15:33446 (R;HU)
Fluid-dynamics of the nuclear surface Fermi-layer, 15:33576 (R;HU)
Gauge-invariant, nonperturbative approach to the infrared-finite bound-state problem in QCD, 15:33504 (R;HU)
Impurity flux collection at the plasma edge of the tokamak MT-1, 15:33783 (R;HU)
Mini-inflation prior to the cosmic confinement transition, 15:33296 (R;HU)
Monte Carlo modelling for neutron guide losses, 15:32353 (R;HU)
On the minimum uncertainty of space-time geodesics, 15:33706 (R;HU)
Some notes on stationary vacuum space-times with shearing non-geodesic eigenrays, 15:33708 (R;HU)
Strong coupling analogue of the Born series, 15:33707 (R;HU)
Studies on vibration of fuel rods Pt. 1: Mechanical models of vibration of fuel rods in PWRs, 15:32340 (R;HU;In Hungarian)
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Vapor Barrier Assessment Program for delaying and diluting heavier-than-air hydrogen fluoride vapor clouds: Summary report, 15:32136 (R;US)

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Contribution to the analytical and numerical evaluation of oil well equilibrium for any cross section under a uniform pressure and an anisotropic stress field, 15:32130 (R;FR;In French)

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Study of axial mixing phenomena in pulse columns equipped with crown-disk packing, 15:32196 (R;FR;In French)

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A suggestion on the pair QSO triplets 1130+106 {B,A,C}, {x,y,z}, 15:33294 (R;BR)
Chiral symmetry breaking in QED_3: bifurcation of the fermionic self-energy, 15:33503 (R;BR)
Mass differences of light hadron isomultiplets, 15:33440 (R;BR)
Nucleon and isobar properties in a relativistic Hartree-Fock calculation with vector Richardson potential and various radial forms for scalar mass terms, 15:33569 (R;BR)
Observed supersymmetry in baryon and meson spectra with IBFM, the interacting boson fermion model, 15:33441 (R;BR)
On the structure of quantum phase space, 15:33704 (R;BR)
Prediction for mesonic spectrum from the discrete quark-gluon states of a finite size bag, 15:33442 (R;BR)
Squeezed states representation; an λ-expansion of statistical mechanics, 15:33703 (R;BR)
Symplectic bosons, Fermi fields and super Jordan algebras, 15:33702 (R;BR)

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Parameters influencing porosity in sands and sandstones, 15:32125 (R;NO)
Permeability patterns in some fluvial sandstones: An outcrop study from Yorkshire, North East England, 15:32124 (R;NO)

Three-dimensional permeability and fluid flow, 15:32131 (R;NO)

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Replacement of core components in the Advanced Test Reactor, 15:32350 (R;US)
Replacement of the Advanced Test Reactor control room, 15:32351 (R;US)

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Renewable-resource management in agriculture. World Bank operations evaluation study, 15:32455 (R;US)

International Centre for Theoretical Physics, Trieste (Italy)
1/n-expansion and scaling for the Stark effect in Rydberg atoms, 15:33334 (R;XA)
2+1 topological term, anyons and their possible application in high T_c superconductivity, 15:33496 (R;XA)
A comment on anisotropic spheres admitting one parameter group of conformal motions, 15:33671 (R;XA)
A corollary to Kodaira-Spencer's theorem on continuity of eigenvalues, 15:33692 (R;XA)
A remark on Euclidean-domain types, 15:33697 (R;XA)
A review of self generated B-field in ICF corona, 15:33816 (R;XA)
An error estimate for Tremolieres method for the discretization of parabolic variational inequalities, 15:33699 (R;XA)
An existence theorem for periodic solutions and applications to some third order nonlinear differential equations, 15:33676 (R;XA)
An instability theorem for a certain sixth order differential equation, 15:33670 (R;XA)
Anyons and Chern-Simons theory on compact spaces of finite genus, 15:33497 (R;XA)
Asymptotics of Laplace-Dirichlet integrals, 15:33693 (R;XA)
Beltrami algebra and symmetry of Beltrami equation on Riemann surfaces, 15:33681 (R;XA)
Classical extended conformal symmetries, 15:33502 (R;XA)
Comment on phenomenology of the almost standard model, 15:33439 (R;XA)
Construction of mixed fermionic-bosonic string models in four dimensions, 15:33486 (R;XA)
Continuum states of the Klein-Gordon equations for vector and scalar interactions, 15:33668 (R;XA)
Correlated basis function method for fermions on a lattice: The 1-dimensional Hubbard model, 15:33626 (R;XA)
Decays $D \rightarrow Kev$, $D \rightarrow K^*ev$, $D \rightarrow \pi ev$ in QCD sum rules method, 15:33437 (R;XA)
Dissipative quantum maps, 15:33672 (R;XA)
Does nature place a fundamental limit on strength?, 15:33695 (R;XA)
Effect of retardation on the reflectance properties of the metallic Fibonacci quasi-superlattice, 15:33623 (R;XA)
Electron acoustic and magnetoacoustic modes in a magnetized beam plasma system, 15:33739 (R;XA)
Failure analysis of leakage current in plastic encapsulated packages, 15:33006 (R;XA)
Heavy quarkonium production close to neutral gauge E_6 bosons in e^+e^- annihilation, 15:33435 (R;XA)
Higher loop contributions to effective potential of gauge theory at high temperature, 15:33487 (R;XA)
How to interpret the validity of the single band model?, 15:33620 (R;XA)
Information loss down a black hole, 15:33293 (R;XA)
Introductory lectures on conformal field theory and strings, 15:33500 (R;XA)
Measurement of gravitational acceleration of antimatter, 15:33740 (R;XA)
Membranes, strings, extended elementary particles as singularities of fields, 15:33488 (R;XA)
New real space correlated-basis-functions approach for the electron correlations of the semiconductor inversion layer, 15:33622 (R;XA)
Old and new ideas in the theory of quantum measurement, 15:33683 (R;XA)
On a calculation of the ground-state energy in quantum mechanics, 15:33696 (R;XA)
On a phase structure of a three-dimensional ϕ^4 field theory, 15:33501 (R;XA)
On an isospectrality question over compact Riemann surfaces, 15:33691 (R;XA)
On comparable L^p-norms of subadditive functions on topological groups, 15:33678 (R;XA)
On Dirac's conjecture for Hamiltonian systems with first and second class constraints, 15:33485 (R;XA)
On Einsteinian 4-submanifolds in E^6, 15:33669 (R;XA)
On hydrogen chemisorption on metals: The electron correlation effects, 15:33625 (R;XA)
On the dimensional reduction of a gravitational theory containing higher-derivative terms, 15:33700 (R;XA)
On the dynamic polarizability of atoms, 15:33332 (R;XA)
On the dynamics of severe thunderstorms, 15:33059 (R;XA)
On the relation between the absolute parallelism spaces and spaces having a GL(4) connection, 15:33495 (R;XA)
On the unitarity of string propagation on SU(1,1), 15:33493 (R;XA)
Operator formalism of multi-pole Virasoro algebra on Riemann sphere, 15:33498 (R;XA)
Oscillatory and nonoscillatory behaviour of solutions of an equation alternately of retarded and advanced type, 15:33684 (R;XA)
Pairing with fractional angular and "spinor" gap, 15:33653 (R;XA)
Parity violation and superconductivity in doped Mott insulators, 15:33654 (R;XA)
Periodic solutions of certain fifth order differential equations, 15:33685 (R;XA)
Product integration rules at Clenshaw-Curtis and related points: A robust implementation, 15:33682 (R;XA)
Propagation of electromagnetic radiation in a random field of gravitational waves and space radio interferometry, 15:33673 (R;XA)
QED corrected extra Z boson effects at e^+e^- colliders, 15:33436 (R;XA)
Quantifying the FIR interaction enhancement in paired galaxies, 15:33292 (R;XA)
Quantum chaos and dissipation: Lyapunov exponents, 15:33674 (R;XA)
Quantum gravity in two dimensions and the SL(2,R) current algebra, 15:33494 (R;XA)
Quantum Ising model on hierarchical structures, 15:33624 (R;XA)
Radiative decay of the bottom quark and the $WW\gamma$ coupling, 15:33438 (R;XA)
Recurrence relations and weight functions for approximation by orthonormal polynomials, 15:33680 (R;XA)
Self-consistent hole motion and spin excitations in a quantum antiferromagnet, 15:33621 (R;XA)
Solution of the Stokes system by boundary integral equations and fixed point iterative schemes, 15:33687 (R;XA)
Some overdetermined systems of complex partial differential equations, 15:33690 (R;XA)
Strong-field Stark effect: Perturbation theory and 1/n-expansion, 15:33333 (R;XA)
Superconductivity in mixed boson-fermion systems, 15:33652 (R;XA)
Superconformal algebra and central extension of meromorphic vector fields with multipoles on super-Riemann sphere, 15:33490 (R;XA)
Surface photovoltage spectroscopy of real n-type GaAs(110) surfaces, 15:33619 (R;XA)
Temporal behaviour of self generated magnetic field and its influence on inhibition of thermal flux in ICF plasma, 15:33815 (R;XA)
The center of the enveloping algebra of the semidirect product of the Heisenberg Lie algebra h_n and a reductive lie algebra S the rank of which is equal to 1 or 2, 15:33679 (R;XA)
The combinatorics computation for Casimir operators of the symplectic Lie algebra and the application for determining the center of the enveloping algebra of a semidirect product, 15:33686 (R;XA)
The Cousin problems for an overdetermined system of complex partial differential equations, 15:33688 (R;XA)
The Cousin problems in the viewpoint of partial differential equations, 15:33689 (R;XA)
The effects of rainfall energy on soil erosion in Southern Nigeria, 15:33128 (R;XA)
The first order phase transition for six-state Potts model on 2-dimensional random triangle lattice, 15:33489 (R;XA)

The location of zeros using generalizations of Newton's method, 15:33698 (R;XA)
The relative probability for the recoilless Λ-production in nuclei in the plane wave impulse approximation, 15:33568 (R;XA)
The symplectic structure of submanifolds of Kaehler manifolds of non-positive curvature, 15:33701 (R;XA)
Thermodynamics and structure of liquid alkali metals from the charged-hard-sphere reference fluid, 15:32805 (R;XA)
Topology of singularities and phase diagram of N=2 superconformal field theories, 15:33492 (R;XA)
Total cross section of highly excited strings, 15:33499 (R;XA)
Trajectories of renormalization group flows on the phase diagram of N=2 superconformal field theories, 15:33491 (R;XA)
Unexpected properties of the centrifugal force, 15:33694 (R;XA)
Uniform dissipative solutions for some fourth order nonlinear differential equations, 15:33675 (R;XA)
Weighted norm inequalities for Riemann-Liouville fractional integral, 15:33677 (R;XA)

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General report of the Insurance Study Committee, 15:32367 (R;IT)
Risks and nuclear insurance, 15:32368 (R;IT)

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An evaluation of the known remaining oil resource in the State of Texas: Project on Advanced Oil Recovery and the States, 15:32147 (R;US)

J

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A study on the heating and diagnostic of a tokamak plasma by electromagnetic waves of the electron cyclotron range of frequencies, 15:33763 (R;JP;In Japanese)
Advanced marine reactor: Discussion of a soaking the reactor vessel in the water containment vessel upon the trial studies, 15:32327 (R;JP;In Japanese)
Benchmarking of FEMAXI-IV code with fuel irradiation data in power reactors, 15:32320 (R;JP;In Japanese)
CCS-I: a code to analyze a dynamic behavior of uranium enrichment process in a centrifuge cascade: An application to the safeguards effectiveness assessment, 15:33847 (R;JP)
CRUSH: a simplified computer program for impact analysis of radioactive material transport casks, 15:33846 (R;JP)
Data report for ROSA-IV LSTF 5% cold leg break LOCA experiment Run SB-CL-08, 15:32370 (R;JP)
Data report for ROSA-IV LSTF 5% hot leg break experiment Run SB-HL-01, 15:32372 (R;JP)
Determination of the long-lived nuclides in biological shielding concrete, ion exchange resin and fuel storage pool water of JPDR, 15:32371 (R;JP;In Japanese)
Development of high-power X-ray generation target for radiation processing, 15:32933 (R;JP;In Japanese)
Effect of high temperature neutron irradiation on physical properties of OGL-1 graphite block, 15:32703 (R;JP;In Japanese)
Evaluation of reactivity coefficients for High Temperature Engineering Test Reactor (HTTR), 15:32352 (R;JP;In Japanese)
Evaluation report on CCTF Core-II reflood test C2-AA2 (Run 58): Investigation of downcomer injection effects, 15:32373 (R;JP)
Experiments on tritium behavior in beryllium, (2): Tritium released by recoil and diffusion, 15:32547 (R;JP;In Japanese)
Filler metal development for hastelloy alloy XR, 15:32546 (R;JP;In Japanese)
HTTR plant dynamic simulation using a hybrid computer, 15:32344 (R;JP;In Japanese)
Sensitivity analyses on reflooding effect on the TMI-2 accident by the SCDAP code, 15:32369 (R;JP;In Japanese)
SONATINA-2H: a computer program for seismic analysis of the two-dimensional horizontal slice HTGR core, 15:32324 (R;JP)
The conceptual design of High Temperature Engineering Test Reactor upgraded through utilizing Pebble-in-Block fuel (UHTTR), 15:32323 (R;JP;In Japanese)

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Neptune's Triton: A moon rich in dry ice and carbon, 15:33310 (R;US)

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System coupling and effects optimization, 15:32886 (R;US)

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Morphological and biochemical investigations into the effects of quartz on bovine alveolar macrophages (BAM) and their organelles, 15:33232 (R;DE;In German)

Karlsruhe Univ. (T.H.) (Germany, F.R.). Fakultaet fuer Physik
Investigations on cooling by forced flow of helium II driven by fountain effect pumps, 15:32865 (R;DE;In German)
Simulation of the build-up phase of a high voltage low pressure gas discharge using Monte-Carlo-methods, 15:32975 (R;DE;In German)

Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Datenverarbeitung in der Technik
Application of near real time accountancy to nuclear material balance data, 15:32257 (R;DE)
Parallel treatment of simulation particle-in-cell codes on SUPRENUM, 15:33782 (R;DE)

Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Genetik und Toxikologie von Spaltstoffen
Morphological and biochemical investigations into the effects of quartz on bovine alveolar macrophages (BAM) and their organelles, 15:33232 (R;DE;In German)

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Coulomb-dissociation of 156 MeV ^{6}Li-projectiles, 15:33553 (R;DE;In German)
Neutron-proton scattering, 15:33444 (R;DE)

Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik
Simulation of the build-up phase of a high voltage low pressure gas discharge using Monte-Carlo-methods, 15:32975 (R;DE;In German)

Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Reaktorbauelemente
Florestan-Material Test, 15:32374 (R;DE;In German)

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Investigations on cooling by forced flow of helium II driven by fountain effect pumps, 15:32865 (R;DE;In German)

Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftreinhaltung (PEF)
Progeny test of Norway Spruce stands in the Black Forest (areas of origin 840 08 and 840 09) aiming at: 1. Improvement of immission tolerance. 2. Conservation of genetic resources of

damaged stands in high altitudes ('Gene Bank'), 15:33233 (R;DE;In German)

Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Kernfusion
Investigations on cooling by forced flow of helium II driven by fountain effect pumps, 15:32865 (R;DE;In German)

Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Nukleare Sicherheit
Florestan-Material Test, 15:32374 (R;DE;In German)

Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Wiederaufarbeitung und Abfallbehandlung
Application of near real time accountancy to nuclear material balance data, 15:32257 (R;DE)

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Proceeding of the symposium on the plan for establishment of Health Physics Research Center, 15:32254 (R;JP;In Japanese)
Summary reports of activities under visiting research program in Research Reactor Institute, Kyoto University, 1988, 15:32354 (R;JP;In Japanese)

L

Laboratoire Leon Brillouin, Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)
Glancing incidence neutron scattering, 15:33614 (R;FR)

Laboratorio Nacional de Computacao Cientifica (LCC), Rio de Janeiro, RJ (Brazil)
Applications of mixed Petrov-Galerkin finite element methods to transient and steady state creep analysis, 15:33709 (R;BR)
Dual and primal mixed Petrov-Galerkin finite element methods in heat transfer problems, 15:33711 (R;BR)
Finite element analysis of nonlinear creeping flows, 15:33710 (R;BR)

Lawrence Berkeley Lab., CA (USA)
A comparison of analytical approaches for wellbore heat transmission in layered formations, 15:33261 (R;US)
Acoustic and elastic diffraction tomography and its application to fracture detection, 15:33262 (R;US)
Development of an Integrated Record Input System (IRIS) for DOE's Technical Information Center, 15:33858 (R;US)
Effect of Cu^{2+} magnetic moments on the superconductivity of $YBa_2Cu_3O_7$: The origin of the "linear term" in the specific heat; The volume fraction of superconductivity, 15:32613 (R;US)
Elastic scattering and total cross sections, 15:33407 (R;US)
Fabrication of a high T_c superconducting bolometer, 15:32989 (R;US)
Fermion loops in the effective potential of N = 1 supergravity, with application to no-scale models, 15:33506 (R;US)
Measurements of 1/f noise in A-Si:H pin diodes and thin-film-transistors, 15:32977 (R;US)
Two-photon physics, 15:33406 (R;US)

Lawrence Livermore National Lab., CA (USA)
A critical appraisal of model simulations, 15:33107 (R;US)
A hierarchical approach to large space structure control, 15:32497 (R;US)
A numerical study of silane combustion, 15:32836 (R;US)
A parametric investigation of electrical effects on aerosol scavenging by droplets over large fires, 15:33108 (R;US)
A preliminary evaluation of ADPIC [atmospheric diffusion particle-in-cell] model performance on selected ANATEX [Across North America Tracer Experiment] releases using observed, analyzed, and dynamically predicted winds, 15:33109 (R;US)
Altitude-velocity envelope for a moving neutron detector, 15:32980 (R;US)
Ambient-temperature creep failure of silver-aided diffusion bonds between steel, 15:32558 (R;US)
Analysis of explosions in hard rocks: The power of discrete element modeling, 15:33039 (R;US)
Application of AMS [accelerator mass spectrometry] to the biomedical sciences, 15:33196 (R;US)
Applications of strained layer superlattices, 15:32715 (R;US)
Auto-ignition temperatures of binary mixtures of alkanes in a closed vessel: Comparisons between experimental measurements and numerical predictions, 15:32837 (R;US)
Brilliant pebbles, 15:33044 (R;US)
Burning mechanism and regression rate of RX-35-AU and RX-35-AV as a function of HMX particle size measured by the hybrid closed bomb-strand burner, 15:33031 (R;US)
Characterization of disruptions in the Microwave Tokamak Experiment, MTX, 15:33787 (R;US)
Climate Caucus report: Opportunities for bridging the gaps from effects to impacts, 15:33103 (R;US)
Combustion of n-butane and isobutane in an internal combustion engine: A comparison of experimental and modeling results, 15:32520 (R;US)
COYOTE: A computer program for 2-D reactive flow simulations, 15:33387 (R;US)
Design of a gun system for in-situ compressive strength measurements, 15:33037 (R;US)
Development of a high-tensile-strain plastic-bonded TATB explosive, 15:33030 (R;US)
Development of a large scale Nd:YAG growth process, 15:32884 (R;US)
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Engine knock predictions using a fully-detailed and a reduced chemical kinetic mechanism, 15:32519 (R;US)
Induction linac energy regulation via injector current modulation, 15:32940 (R;US)
Injection systems for AMS: Simultaneous vs. sequential, 15:32943 (R;US)
KD*P frequency doubler for high average power applications, 15:32885 (R;US)
Kinetic modeling of ethene oxidation at low and intermediate temperatures, 15:32789 (R;US)
Lawrence Livermore National Laboratory RCRA Part B health risk assessment: Phase 2, Hazardous waste management units: Appendices, 15:33230 (R;US)
Listening to turbulence: An example of scientific audiolization, 15:33388 (R;US)
LLNL/UC [Lawrence Livermore National Laboratory]/[University of California] AMS [accelerator mass spectrometry] facility and research program, 15:32941 (R;US)
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Microwave Tokamak Experiment: Overview and status, 15:33824 (R;US)
Modeling jet penetration in glass, 15:33033 (R;US)
Modeling of Zircaloy cladding degradation under repository conditions, 15:32239 (R;US)
Modeling pulse driven antenna systems with finite differences, 15:32887 (R;US)
Multichip packaging technology with laser-patterned interconnects, 15:32714 (R;US)
Multiframe x-ray images from a single meander stripline coated on a microchannel plate, 15:32979 (R;US)
Nanometer-scale pulsed laser modification of the basal plane of graphite observed with STM [scanning tunneling microscopy], 15:32716 (R;US)
New surface atomic structures for III-V(110)-p(1×1)-Sb(1ML): Chemical bonding and electronic structure, 15:32808 (R;US)
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Seismic imaging for velocity and attenuation structure in geothermal fields, 15:32297 (R;US)
Sensor fusion methodology for remote detection of buried land mines, 15:33034 (R;US)
Shock tube ignition of isomers of octane, 15:32167 (R;US)
SSRL-PEP ring divertor channel entrance thermal stress analysis for new bending magnet loads, 15:32961 (R;US)
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The new LLNL AMS spectrometer, 15:32942 (R;US)
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The search for high energy low vulnerability explosives, 15:33029 (R;US)
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Turbulence modeling in the SHALE code, 15:33386 (R;US)

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Demonstration of the feasibility of laser induced fluorescence for arc jet flow diagnostics, 15:32866 (R;US)

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Destruction of propellant components in supercritical water, 15:32806 (R;US)
Economics of nonrenewable energy resources, 15:32453 (R;US)
Encoding of the Burgess metal electrical resistivity model into SESAME format and its adaptation to the metal nickel, 15:32548 (R;US)
Exchange ratios for singlet boost-phase defenders, 15:33040 (R;US)
Expert systems for flow cytometry data analysis: A preliminary report, 15:33214 (R;US)
Graph Structure Model, 15:33849 (R;US)
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Interaction of objects in manufacturing process simulation, 15:32852 (R;US)
Numerical simulations of the mountain iron tracer data, 15:33061 (R;US)
Onboard detection of intrinsic Lyα radiation from a neutral particle beam, 15:33041 (R;US)
Safe venting of hydrogen, 15:32265 (R;US)
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PARTITION: A program for defining the source term/consequence analysis interface in the NUREG–1150 probabilistic risk assessments: User's guide, 15:32417 (R;US)
PRAMIS: Probability Risk Assessment Model Integration System: User's guide, 15:32418 (R;US)
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Assessment of TRAC-PF1/MOD1 Version 14.3 using separate effects critical flow and blowdown experiments: Volume 2, Figures, 15:32424 (R;US)
The development and evaluation of programmatic performance indicators associated with maintenance at nuclear power plants: Main report: Volume 1, 15:32420 (R;US)
The development and evaluation of programmatic performance indicators associated with maintenance at nuclear power plants: Appendices: Volume 2, 15:32421 (R;US)

O

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Oak Ridge Gaseous Diffusion Plant, TN (USA)
Binder with base of aqueous solution of alkaline silicates, how to obtain it and its applications, 15:32704 (TG;US)
Demonstration of noble gas collection using the cryogenic technique, 15:33060 (R;US)

Oak Ridge National Lab., TN (USA)
A high-sensitivity, position-sensitive fission chamber for subcriticality measurement of spent fuel, 15:32197 (R;US)
A probabilistic approach to the evaluation of the PTS [pressurized thermal shock] issue, 15:32356 (R;US)

Atomic scale imaging of the structure and chemistry of semiconductor interfaces, 15:32698 (R;US)
Au-Ge-Ni-Ti ohmic contacts on gallium arsenide, 15:32537 (R;US)
CO_2 emissions from production and combustion of fuel ethanol from corn, 15:32270 (R;US)
Convoy electrons, 15:33616 (R;US)
Determination of airborne organics by direct sampling mass spectrometry, 15:33050 (R;US)
Dust and ventilation effects on radiant barriers: Cooling season energy measurements: Final report, 15:32484 (R;US)
Electron microscopy of interfaces in silicon carbide whisker-reinforced alumina composites, 15:32699 (R;US)
Evaluating direct toxicity and food-chain effects in aquatic systems using natural periphyton communities, 15:33139 (R;US)
Executive summary: Reactor critical benchmark calculations for burnup credit applications, 15:32333 (R;US)
Experimentation and concept formation by an autonomous mobile robot, 15:32843 (R;US)
First-phase study design for the US Navy Radon Assessment and Mitigation Program (NAVRAMP), 15:32481 (R;US)
Friction and wear of whisker-reinforced ceramic composite bodies, 15:32609 (R;US)
HAZ liquation cracking behavior in newly developed lean 316 stainless steels, 15:32045 (R;US)
Hydrolysis of cellobiose by immobilized β-glucosidase entrapped in maintenance-free gel spheres, 15:33215 (R;US)
Impact of automated feeder reconfiguration on capacity utilization at the Athens Utilities Board, 15:32429 (R;US)
Improvements in macroreticular particles for ion-exchange and gel-permeation chromatography, 15:32700 (R;US)
Initial calorimetry experiments in the Physics Division, ORNL [Oak Ridge National Laboratory], 15:33723 (R;US)
Initial parametric results using CYCLEZ—An LMTD-specified, Lorenz-Meutzner cycle refrigerator-freezer model, 15:32503 (R;US)
International decision making and global climate change: Lessons of prior resource management efforts for consensus building, 15:33053 (R;US)
Irradiation effects on impact behavior of 12Cr-1MoVW and 2 1/4Cr-1Mo steels, 15:32538 (R;US)
Mechanical property characterization of fiber-reinforced SiC matrix composites, 15:32071 (R;US)
Melting of iron-aluminide alloys, 15:32044 (R;US)
Micropolyelectrons as possible sources of the anomalous positron peaks in heavy-ion reactions, 15:33566 (R;US)
Microwave processing of silicon nitride, 15:32605 (R;US)
Morphological and structural characterization of the spinodal decomposition of Fe-Cr alloys, 15:32536 (R;US)
Multi-criteria position and configuration optimization for redundant platform/manipulator systems, 15:32847 (R;US)
Multicomponent ion-exchange equilibria in chabazite zeolite, 15:32203 (R;US)
Multilaboratory validation study of PCBs in soils using Soxtec® extraction technique (Method 3541), 15:33119 (R;US)
Neutron exposure parameters for the metallurgical test specimens in the sixth heavy-section steel irradiation series, 15:32338 (R;US)
Optimal positioning of redundant manipulator-platform systems for maximum task efficiency, 15:32846 (R;US)
Performance experience with radon mitigation systems, 15:32480 (R;US)
Performance of multiple tasks by an autonomous robot using visual and ultrasound sensing, 15:32845 (R;US)
Potential responses of landscape boundaries to global environmental change, 15:33051 (R;US)
Preparative purification of Trichoderma reesei native and "core" Cellobiohydrolase I by electrophoresis and chromatofocussing, 15:33192 (R;US)
QADS: A multidimensional point kernel analysis module, 15:33596 (R;US)
Rapid determination of nicotine in urine by direct thermal desorption ion trap mass spectrometry, 15:32782 (R;US)
Summertime elevation of radon in southern Appalachian homes, 15:33049 (R;US)
Targets of opportunities for plastics recycling and source reduction, 15:32514 (R;US)
The effects of chromium and titanium gettering on the operation of the Advanced Toroidal Facility, 15:33806 (R;US)
The insulation irradiation test program for the Compact Ignition Tokamak, 15:33807 (R;US)
The response of MOV and SiC arresters to steep-front longer duration current pulses, 15:32434 (R;US)
The theory of electron-ion collisions: The role of doubly excited states, 15:33328 (R;US)
Thermodynamic calculations for mixtures of environmentally safe refrigerants using the Lee-Kesler-Ploecker equation of state, 15:32701 (R;US)
Time optimal trajectories for a two wheeled robot, 15:32853 (R;US)
Transport studies of radon in limestone underlying houses, 15:33118 (R;US)
Ultrasound and visual sensor feedback and fusion, 15:32844 (R;US)
Unusual formaldehyde-induced hypersensitivity in two schoolgirls, 15:33257 (R;US)
Visual animation of parallel algorithms for matrix computations, 15:33842 (R;US)
Weldability of nickel aluminides, 15:32542 (R;US)
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P

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Effects of valley meteorology on forest pesticide spraying, 15:33219 (R;US)
Evaluations of the effects of the Columbia River on the unconfined aquifer beneath the 1301-N Liquid Waste Disposal Facility, 15:32232 (R;US)
Evapotranspiration studies for protective barriers: FY 1988 status report, 15:32227 (R;US)
Field Lysimeter Test Facility: Second year (FY 1989) test results, 15:32228 (R;US)
Fiscal year 1989 annual report for the Sensors Development Program: Inert Electrodes Program, 15:32511 (R;US)
Geohydrology of the 218-W-5 Burial Ground, 200-West Area, Hanford Site, 15:32231 (R;US)
Hanford Environmental Dose Reconstruction Project: Monthly report, 15:33102 (R;US)
Hanford Site National Environmental Policy Act (NEPA) characterization: Revision 2, 15:33101 (R;US)
Public perception and acceptance of the siting of nuclear waste facilities in seven countries, 15:32218 (R;US)
Remedial Action Assessment System (RAAS): Evaluation of selected feasibility studies of CERCLA [Comprehensive Environmental Response, Compensation, and Liability Act] hazardous waste sites, 15:32229 (R;US)
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Electrochemical reduction of actinide ions in aqueous solution and some examples of its application, 15:32833 (R;FR)
Isoscalar giant resonances in a relativistic model, 15:33572 (R;FR)
Separation of californium from actinides and lanthanides in aqueous solution by electrochemical formation of amalgams, 15:32787 (R;FR)
The pion in the deuteron, 15:33573 (R;FR)

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Nuclear dynamics with the finite range Gogny force, 15:33577 (R;FR)

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FIDAS: a three-fluid subchannel code for dryout prediction in rod bundles, 15:32869 (R;JP)
Validation of film dryout model in a three-fluid code FIDAS, 15:32870 (R;JP)

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Radiation-related posterior lenticular opacities in Hiroshima and Nagasaki atomic bomb survivors based on T65DR and DS86 dosimetry systems, 15:33228 (R;JP)
Smoking and serum proteins in atomic bomb survivors in Hiroshima, 15:33227 (R;JP)
The shape of the cancer mortality dose-response curve for atomic bomb survivors, 15:33229 (R;JP)

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1/f noise in irradiated MOS devices, 15:32987 (R;US)
A comparison of CTH predictions with experimental armor/anti-armor data for long rod penetrators in two and three dimensions, 15:32873 (R;US)
A direct absorber reactor/receiver for solar thermal applications, 15:32290 (R;US)
A new technique for hardening optically-triggered thyristors, 15:33043 (R;US)
A transformer coupled semiconductor bridge igniter for low voltage ignition from a high voltage source, 15:33025 (R;US)
Aerosol cloud generation experiments, 15:33026 (R;US)
Aerosol Dynamics Laboratory, 15:33000 (R;US)
An algorithm for using a slide-screw tuner as a computer-controlled impedance, 15:32883 (R;US)
An examination of the 1-MeV equivalent silicon damage methodology, 15:32557 (R;US)
Analysis of core damage frequency: Surry, Unit 1 internal events: Volume 3, Revision 1, Part 1, 15:32414 (R;US)
Analysis of core damage frequency, Surry, Unit 1 internal events appendices: Volume 3, Revision 1, Part 2, 15:32415 (R;US)
Basic data report for drillhole H-12 (Waste Isolation Pilot Plant-WIPP), 15:32236 (R;US)
Characterization of chemically prepared PZT thin films, 15:32712 (R;US)
Chlorine reactive-ion-beam etching of InSb and $InAs_{0.15}Sb_{0.85}$/InSb strained-layer-superlattices, 15:32713 (R;US)
Development of a point-contact solar cell using high-volume processing techniques: Final report, 15:32284 (R;US)
Distance and clearance perception using forward-looking, vehicular television systems, 15:32496 (R;US)
Dosimetry considerations for the high-energy photon/electron environment of HERMES III: Implications for experiments and modeling, 15:32937 (R;US)
Evaluation of mixed alcohol production processes and catalysts, 15:32273 (R;US)
Field dependence of interface trap buildup in Si-gate MOS devices, 15:32882 (R;US)
Flash x-ray measurements with a time projection Compton spectrometer, 15:33009 (R;US)
Geomechanical analyses in support of the Waste Isolation Pilot Plant (WIPP), 15:32237 (R;US)
Graphical analysis of barrel-tamped explosively accelerated flyer plates, 15:33027 (R;US)
Improving the performance of $InAs_{1-x}Sb_x$/InSb infrared detectors grown by metal organic chemical vapor deposition, 15:32711 (R;US)
Liquid crystal coatings for surface shear stress visualization in hypersonic flows, 15:32709 (R;US)
LLUVIA: A program for one-dimensional, steady-state flow through partially saturated porous media, 15:32235 (R;US)
Lost circulation technology development projects, 15:32299 (R;US)
Method of fabricating an oxide-aluminum humidity sensor, 15:33002 (R;US)
Model based, sensor directed remediation of underground storage tanks, 15:32858 (R;US)
Modeling laser ignition of explosives and pyrotechnics: Effects and characterization of radiative transfer, 15:33028 (R;US)
Modeling of runaway electron damage for the design of tokamak plasma facing components, 15:33822 (R;US)
Numerical modeling tools for transient electromagnetic problems, 15:33036 (R;US)
PARTITION: A program for defining the source term/consequence analysis interface in the NUREG–1150 probabilistic risk assessments: User's guide, 15:32417 (R;US)
PRAMIS: Probability Risk Assessment Model Integration System: User's guide, 15:32418 (R;US)
Predicting switched-bias response from steady-state irradiations, 15:33042 (R;US)
Primary Standards Laboratory report: 2nd half 1989, 15:32965 (R;US)
Properties of films prepared from low surface area/density alumina-silica, 15:32615 (R;US)
Radiation hardening of a high voltage IC technology (BCDMOS), 15:32988 (R;US)
Rapid thermal processing of high temperature superconducting fiber, 15:32616 (R;US)
Resistivity measurements of halide-salt/MgO separators for thermal cells, 15:32441 (R;US)
Rock motion simulation and prediction of porosity distribution for a two-void-level retort, 15:32184 (R;US)
Sandia National Laboratories data engineering for DOE production agencies, 15:33863 (R;US)
Sedimentation of particles through quiescent suspensions, 15:33632 (R;US)
Self-discharge study of Li-alloy/FeS_2 thermal cells, 15:32440 (R;US)

Sensor-based automated docking of large payloads, 15:32857 (R;US)
SEU characterization and design dependence of the SA3300 microprocessor, 15:33853 (R;US)
Statistical process control for QML [Qualified Manufacturer's List] radiation hardness assurance, 15:32881 (R;US)
The effect of charge mixture ratio and particle size on igniter plume heat transfer characteristics, 15:32871 (R;US)
The prediction of loads on penetrators into rock via the spherical cavity expansion approximation, 15:33021 (R;US)
Thermal emission model for the anneal of radiation-induced trapped holes, 15:32985 (R;US)
Titanium-boron mixtures as variable heat sources, 15:32437 (R;US)
Total-dose degradation of thin film ferroelectric capacitors, 15:32986 (R;US)
Trapping of deuterium at damage in graphite, 15:32710 (R;US)
Using the XPATHS computer code, 15:32855 (R;US)
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Measurements at Aeroe Windmill park, 15:32307 (R;DK;In Danish)
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Industrial burners for combustion of high concentration water-coal slurries and respective combustion, 15:32116 (R;XE)

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Aerodynamic pressure measurements on a rotating wind turbine blade, 15:32306 (R;US)
Solar resources, 15:32278 (B;US)
Wake deficit measurements on the Jess and Souza Ranches, Altamont Pass, 15:32305 (R;US)

Sonoma Technology, Inc., Santa Rosa, CA (USA)
Southern California Air Quality Study (SCAQS) description of measurement activities. Final report, 15:33093 (R;US)

Southampton Univ. (UK). Dept. of Ship Science
Two-dimensional wind tunnel tests of the SSS Series 1 structurally efficient aerofoils for wind turbines, 15:32308 (R;GB)

Southern Illinois Univ., Carbondale, IL (USA). Coal Extraction and Utilization Research Center
High-sulfur coal research at the SIUC [Southern Illinois University at Carbondale] Coal Technology Laboratory: Quarterly progress report, January 1–March 31, 1990, 15:32041 (R;US)
High-sulfur coal research at the SIUC Coal Technology Laboratory: Quarterly progress report, January 1–March 31, 1990, 15:32042 (R;US)

Southwest Research Inst., San Antonio, TX (USA)
A magnetographic technique for inspection of containment welds through coatings: Final report, 15:32337 (R;US)
Investigation of effects of 60-Hz electric and magnetic fields on operant and social behavior and on the neuroendocrine system of nonhuman primates: Annual report, 15:32435 (R;US)
Simulation of radial expansion of an electron beam injected into a background plasma, 15:32925 (R;US)

Southwest Technology Development Inst., Las Cruces, NM (USA)
Comparative performance analysis: Commercial cut-flower rose production, 15:33218 (R;US)

Space Telescope Science Inst., Baltimore, MD (USA)
Accretion shock geometries in the magnetic variables, 15:33309 (R;US)
Recent progress in understanding the eruptions of classical novae, 15:33300 (R;US)
Shapes of star-gas waves in spiral galaxies, 15:33297 (R;US)
The age of the galactic disk, 15:33299 (R;US)
The disk-halo connection and the nature of the interstellar medium, 15:33298 (R;US)
The volatile composition of comets, 15:33301 (R;US)

SRI International, Menlo Park, CA (USA)
Low-temperature, sulfur-tolerant homogeneous catalysts for the water-gas shift reaction: Final report, 15:32050 (R;US)

Staatliches Amt fuer Atomsicherheit und Strahlenschutz, Berlin (German Democratic Republic)
Standard operational radiation protection instructions for process instrumentation and control engineering applying radiometric equipment containing sealed sources, 15:33605 (R;DD;In German)

Stanford Linear Accelerator Center, Menlo Park, CA (USA)
A summary of the results from LASS [Large Aperture Superconducting Solenoid] and the future of strange quake spectroscopy, 15:33410 (R;US)
Computing and data handling requirements for SSC [Superconducting Super Collider] and LHC [Large Hadron Collider] experiments, 15:32939 (R;US)
Datum definition problems in accelerator alignment, 15:32910 (R;US)
Electrostatic design of the barrel CRID [Cherenkov Ring Imaging Detector] and associated measurements, 15:32978 (R;US)
Performance measurements of hybrid PIN diode arrays, 15:32938 (R;US)
Physics at the 100 GeV mass scale: Proceedings, 15:33398 (R;US)
SLAC [Stanford Linear Accelerator Center] site geology, ground motion and some effects of the October 17, 1989 earthquake, 15:33277 (R;US)

Stanford Univ., CA (USA). Petroleum Research Inst.
A comparison of relative permeability from centrifuging versus coreflooding, 15:32129 (R;US)

Statens Jordbrugstekniske Forsoeg, Horsens (Denmark). Afd. for Driftsteknik og Energi
Poly aromatic hydrocarbons in flue gas from straw-fueled boilers: Pilot investigation, 15:32271 (R;DK;In Danish)
Stichting Natuur en Milieu, Utrecht (Netherlands)
Nature demands stricter limits, 15:32105 (R;NL)
Strasbourg-1 Univ., 67 (France). Centre de Recherches Nucleaires
Beyond spinors, 15:33666 (R;FR)
Jordan algebras and flat potentials at one loop, 15:33667 (R;FR)
Stuttgart Univ. (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme
Modelling of the steam-water-countercurrent flow in the rewetting and flooding phase after loss-of-coolant accidents in pressurized water reactors, 15:32366 (R;DE;In German)
Solution of the multigroup transport equations for fuel element assemblies according to the first collision procedure, 15:32331 (R;DE;In German)
Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden)
Radar investigations at the Saltsjoetunnel - predictions and validation, 15:32238 (R;SE)
Syracuse Univ., NY (USA)
Evaluating cumulative effects of disturbance on the hydrologic function of bogs, fens, and mires, 15:33174 (R;US)

T

TAMS Consultants, Inc., Boston, MA (USA)
Transportation plan for the shuttle bus: Saco-Biddeford-Old Orchard Beach, 15:32494 (R;US)
Technische Univ. Muenchen, Garching (Germany, F.R.). Fakultaet fuer Physik
Prompt leptons from the decays of heavy quarks in the e^+e^- annihilation at energies of 35 and 43 GeV, 15:33408 (R;DE;In German)
Technischer Ueberwachungs-Verein Bayern e.V., Muenchen (Germany, F.R.)
Wind tunnel tests on the evaluation of interferences due to buildings on the propagation of radioactive materials after release from nuclear facilities. Report and annex, 15:33046 (R;DE;In German)
Technology Applications, Inc., Jacksonville, FL (USA)
Nuclear power applications of NASA control and diagnostics technology: Volume 1, Project results: Final report, 15:32341 (R;US)
Nuclear power applications of NASA control and diagnostics technology: Volume 2, Technical report: Final report, 15:32342 (R;US)
Nuclear power applications of NASA control and diagnostics technology: Volume 3, Users manual: Final report, 15:32343 (R;US)
Tennessee Univ., Chattanooga, TN (USA). School of Engineering
The BENCHMARK™ code: Simulation of hourly generation: User's guide, 15:32430 (R;US)
Tennessee Univ., Knoxville, TN (USA). Dept. of Chemistry
Polymer-based separations: Synthesis and application of polymers for ionic and molecular recognition: Annual performance report, August 1, 1989–July 31, 1990, 15:32702 (R;US)
Texas A and M Univ., College Station, TX (USA)
Polychlorinated biphenyls: Progress and problems, 15:32807 (R;US)
Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry
New directions for the catalytic conversion of methane. Annual report, January-December 1989, 15:32181 (R;US)
Texas A and M Univ., College Station, TX (USA). Geodynamics Research Inst.
Subduction zone tectonic studies to develop concepts for the occurrence of sediment subduction (Phase 2): Volume 1: Final report, 15:32168 (R;US)
Subduction zone tectonic studies to develop concepts for the occurrence of sediment subduction (Phase 2): Volume 2: Final report, 15:32169 (R;US)
Subduction zone tectonic studies to develop concepts for the occurrence of sediment subduction (Phase 2): Volume 3: Final report, 15:32170 (R;US)
Texas Univ., Austin, TX (USA). Bureau of Economic Geology
Geologic evaluation of critical production parameters for coalbed methane resources. Part 1. San Juan Basin. Annual report, August 1988-July 1989, 15:32106 (R;US)
Organic petrography, and organic geochemistry of Texas Tertiary coals in relation to depositional environment and hydrocarbon generation, 15:32082 (R;US)
Texas Univ., Austin, TX (USA). Dept. of Chemical Engineering
Urban aerosol transformation and transport modeling. Report for October 1985-October 1988, 15:33091 (R;US)
Texas Univ., Austin, TX (USA). Fusion Research Center
A portable and independent edge fluctuation diagnostic: Technical progress report, September 14, 1989–May 14, 1990, 15:33736 (R;US)
Plasma confinement theory and transport simulation: Technical progress report, November 1, 1989–October 31, 1990, 15:33735 (R;US)
Texas Experimental Tokamak: Technical progress report, April 1989–April 1990, 15:33811 (R;US)
Texas Univ., Austin, TX (USA). Inst. for Fusion Studies
Fluctuation and thermal energy balance for drift-wave turbulence, 15:33737 (R;US)
Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study
A consistent treatment of medium effects on hypernuclear pi-mesonic decay, 15:33337 (R;JP)
BRS invariant stochastic quantization of Einstein gravity, 15:33705 (R;JP)
BRS symmetry in stochastic quantization of the gravitational field, 15:33476 (R;JP)
Mass systematics of hypothetical neutral objects in heavy-ion collisions and in e^+ heavy-ion interactions, 15:33336 (R;JP)
Nuclear Landau-Zener promotion in the reactions of the system $^{13}C + {}^{16}O \rightarrow {}^{12}C + {}^{17}O$, 15:33531 (R;JP)
Structure and RF characteristics of the INS 25.5-MHz split coaxial RFQ, 15:32923 (R;JP)
Super-hypernuclei in the quark-shell model, 3, 15:33571 (R;JP)
Zero modes in vortex-fermion system with compact extra space, 15:33477 (R;JP)
Tokyo Univ., Tokai, Ibaraki (Japan). Nuclear Engineering Research Lab.
Proceedings of the 2nd Yayoi workshop on fusion reactor engineering, 15:33825 (R;JP;In Japanese)
Toulouse-3 Univ., 31 (France). Centre de Physique Atomique
Contribution to the study of a steam arc plasma. Application to pulverized coal gasification, 15:32070 (R;FR;In French)
Transportation Systems Center, Cambridge, MA (USA)
Federal regulations needing amendment to stimulate the production and introduction of electric/solar vehicles. A report to Congress, January 1990, 15:32524 (R;US)
TRW Energy Products Group, Redondo Beach, CA (USA). Combustion Business Unit
Utility retrofit demonstration using TRW slagging combustor technology: Environmental Assessment, 15:32309 (R;US)
Tuebingen Univ. (Germany, F.R.). Fakultaet fuer Physik
Coulomb-dissociation of 156 MeV ^{6}Li-projectiles, 15:33553 (R;DE;In German)

U

UKAEA Harwell Lab. (UK). Energy Technology Div.
Camborne geothermal energy project 2C-5. Final report Phase 2C: October 1986 - September 1988, 15:32296 (R;GB)
Market review of demand for industrial waste combustors for on-site use, 15:32269 (R;GB)
Ulm Univ. (Germany, F.R.). Abt. Pathologie
Investigations on the detection and prevention of DNA-lesions induced by ionizing irradiation, 15:33220 (R;DE;In German)
Universite de Technologie de Compiegne, 60 (France)
Development of a new fluorometric detection test of sulfatoreducing bacteria type Desulfovibrio. Laboratory evaluation of chemical control of bacteria activity in biocorrosion, 15:32545 (R;FR;In French)

University of Southern California, Los Angeles, CA (USA). Dept. of Mechanical Engineering
Mechanics/heat-transfer relation for particulate materials: Quarterly report, 15:32114 (R;US)

Uniwersytet Jagiellonski, Cracow (Poland)
Correlated positron-electron emission in heavy-ion collisions at the Coulomb barrier, 15:33330 (R;DE)

USDOE Assistant Secretary for Environment, Safety and Health, Washington, DC (USA)
Tiger Team assessment of the Pinellas Plant, 15:33121 (R;US)

USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA)
Utility retrofit demonstration using TRW slagging combustor technology: Environmental Assessment, 15:32309 (R;US)

USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of Business Operations
The cooperative research and development endeavor, 15:32036 (R;US)

USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of the Deputy Assistant Secretary for Coal Technology
Coal Liquefaction Program: Fiscal year 1990, Summary program plan, 15:32046 (R;US)
Heat engines program: Fiscal year 1990, Summary program plan, 15:32113 (R;US)

USDOE Bonneville Power Administration, Portland, OR (USA)
Case study of the regional manufacturers' participation in the manufactured housing RCDP [Residential Construction Demonstration Project], 15:32482 (R;US)
Energy conservation program evaluation: Practical methods, useful results: Proceedings: Volume 2, August 20 and 21 sessions, 15:32479 (R;US)

USDOE Energy Information Administration, Washington, DC (USA). Office of Coal, Nuclear, Electric and Alternate Fuels
Quarterly coal report, October–December 1989, 15:32121 (R;US)

USDOE Energy Information Administration, Washington, DC (USA). Office of Oil and Gas
Petroleum Marketing Monthly, February 1990, 15:32148 (R;US)

USDOE Energy Research Advisory Board, Washington, DC (USA)
Accelerator production of tritium (APT), 15:33812 (R;US)

USDOE Office of Energy Research, Washington, DC (USA). Office of Health and Environmental Research
Subsurface Science Program: Program overview and research abstracts, FY 1989–FY 1990, 15:33122 (R;US)

USDOE Office of Inspector General, Albuquerque, NM (USA). Western Regional Office
Purchase of natural gas by the Albuquerque Operations Office, 15:32173 (R;US)
The natural gas pipeline servicing Los Alamos National Laboratory, 15:32179 (R;US)

USDOE Office of Inspector General, Washington, DC (USA). Capital Regional Office
Management information systems for environmental compliance activities, 15:32205 (R;US)

USDOE Office of Procurement and Assistance Management, Washington, DC (USA). Office of Policy
Guide for technical analysis of cost proposals for acquisition contracts, 15:33836 (R;US)
Guide for technical analysis of budget proposals for financial assistance, 15:33837 (R;US)

USDOE Richland Operations Office, WA (USA)
183-H solar evaporation basins closure/post-closure plan: Revision 2, 15:32209 (R;US)
Environmental restoration and waste management site-specific plan for the Richland Operations Office: Detailed information, 15:32210 (R;US)
Hanford Waste Vitrification Plant Clean Air Act permit application, 15:32211 (R;US)

USDOE Savannah River Operations Office, Aiken, SC (USA)
Savannah River Waste Management Program Plan, FY 1990, 15:32212 (R;US)

USDOE, Washington, DC (USA)
Energy conservation program evaluation: Practical methods, useful results: Proceedings: Volume 2, August 20 and 21 sessions, 15:32479 (R;US)
Technology '89: R and D Laboratory technology transfer program: Accomplishments in technology transfer from DOE [Department of Energy] and it laboratories, 15:32463 (R;US)
Tiger Team environment, safety, and health assessment of the Kansas City Plant, 15:33120 (R;US)

Ustav Jaderneho Vyzkumu CSKAE, Rez (Czechoslovakia)
Determination of neutron flux densities in WWR-S reactor core, 15:32355 (R;CS;In Czech)
HTGR reactor fuel, 15:32325 (R;CS;In Czech)
Main tasks of the Nuclear Research Institute in the period till the year 2000: Preliminary version, 15:33835 (R;CS;In Czech)

Utah Geological and Mineral Survey, Salt Lake City, UT (USA)
The Newcastle geothermal system, Iron County, Utah: Geology, hydrology, and conceptual model, Volume 1: Final report, 15:32295 (R;US)

V

Van Baerle and Cie AG (Switzerland)
Binder with base of aqueous solution of alkaline silicates, how to obtain it and its applications, 15:32704 (TG;US)

Versar, Inc., Columbia, MD (USA)
Long-term benthic monitoring studies in the freshwater portion of the Potomac River: 1983 to 1985, cumulative report. Volume 1. Text, 15:33143 (R;US)
Long-term benthic monitoring studies in the freshwater portion of the Potomac River: 1983 to 1985, cumulative report. Volume 2. Appendices, 15:33144 (R;US)

W

Washington Univ., St. Louis, MO (USA)
[Hydroxyproline-rich glycoproteins of the plant cell wall]: Progress report, June 1989–June 1990, 15:33193 (R;US)

West Valley Nuclear Services Co., Inc., West Valley, NY (USA)
West Valley Demonstration Project annual report to Congress, 15:32243 (R;US)

West Virginia Univ., Morgantown, WV (USA). Coll. of Engineering
Ground movements associated with gas hydrate production in geologic media: Final report, 15:32172 (R;US)

West Virginia Univ., Morgantown, WV (USA). Dept. of Mechanical and Aerospace Engineering
Trend analysis of coal gasification product yields in an entrained flow reactor: Final report, 15:32047 (R;US)

West Virginia Univ., Morgantown, WV (USA). Water Research Inst.
Analysis of mutagenic activity of biohazardous organics in Kanawha River sediments. Technical completion report, 15:33181 (R;US)

Western Research Inst., Laramie, WY (USA)
Jet fuels potential of liquid by-products from the Great Plains Gasification Project, 15:32048 (R;US)
Western states enhanced oil shale recovery program: Shale oil production facilities conceptual design studies report, 15:32185 (R;US)

Westinghouse Hanford Co., Richland, WA (USA)
Assembly of radioisotope power systems at Westinghouse Hanford Company, 15:32262 (R;US)
North Slope investigation report, 15:33135 (R;US)

Westinghouse Savannah River Co., Aiken, SC (USA)
Control loop and unit operational realtime modeling on a Distributed Control System, 15:32242 (R;US)
WIPP/SRL [Waste Isolation Pilot Plant/Savannah River Laboratory] in-situ tests: MIIT [Materials Interface Interactions Tests] program—Glass/metal interfaces of SRS waste glass, 15:32241 (R;US)

Wisconsin Univ., Madison, WI (USA). Dept. of Physics
The Madison Symmetric Torus, 15:33810 (R;US)

World Meteorological Organization, Geneva (Switzerland)
Atmospheric ozone 1985: Assessment of our understanding of the processes controlling its present distribution and change. Volume 3, 15:33078 (R;CH)

Y

York Research Consultants, Denver, CO (USA)
Annual technical report for the onshore environmental baseline characterization, 15:32161 (R;US)
Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada)
Senior citizens retrofits: Final project summary, 15:32488 (R;CA)
Solar swimming pool: Final project summary, 15:32489 (R;CA)

Personal Author Index

Authors' surnames are indexed in the form appearing in the publication cited; given names generally have been reduced to initials. For documents with multiple authors, each author name is indexed. The entry for a primary author (first author listed on an abstracted document) includes the full document title and citation number. Entries for other authors provide a cross-reference to the primary author. Also included is information on the document type, country of publication, and the document language listed in parentheses in the format (J;FR;In French and English). Accent marks are not input because of computer alphabetization. Spelling and transliteration follow standard conventions.

A

Aarts, J., Proximity effect in superconducting bilayers and multilayers, 15:32596 (J;US)

Aas, B., *See* Moshi, M.G., 15:33557

Abachi, S., Measurement of the branching ratio for the decay $\tau^- \to e^- \bar{\nu}_e \nu_\tau$, 15:33420 (J;US)

Abbott, J.R., Sedimentation of particles through quiescent suspensions, 15:33632 (R;US)

Abdel Wahab, M., On the dynamics of severe thunderstorms, 15:33059 (R;XA)

Abdel-Rassoul, A.A., *See* Xie, Y., 15:32983

Abe, F., Measurement of D^* production in jets from $\bar{p}p$ collisions at $\sqrt{s}$ =1.8 TeV, 15:33413 (J;US)

Search for a light Higgs boson at the Fermilab Tevatron proton-antiproton collider, 15:33424 (J;US)

Two-jet invariant-mass distribution at $\sqrt{s}$=1.8 TeV, 15:33425 (J;US)

Abe, K., Electrostatic design of the barrel CRID [Cherenkov Ring Imaging Detector] and associated measurements, 15:32978 (R;US)

Abe, Michiko, A nation-wide survey of radon indoors and outdoors in Japan: Levels and risks, 15:33064 (RA;JP;In Japanese)

Abe, Shiro, An estimation of contribution to the population dose in Japan: Levels and risks, 15:33601 (RA;JP;In Japanese)

Abe, Siro, *See* Abe, Michiko, 15:33064

Abrajano, T.A., Linear free energy relationships in glass corrosion, 15:32727 (BA;US)

Abramowicz, M.A., Unexpected properties of the centrifugal force, 15:33694 (R;XA)

Abrams, G., *See* Wagner, S.R., 15:33416

See Weir, A.J., 15:33419

Abrams, G.S., *See* Jung, C.K., 15:33415

Abrefah, J., Hydrogen dissolution in and release from nonmetals. II. Crystalline silicon, 15:32771 (J;US)

Reduction of UO_{2+x} by atomic hydrogen, 15:32834 (J;US)

Adair, R.K., A flaw in the universal mirror, 15:33480 (J;US)

Adam, G., Product integration rules at Clenshaw-Curtis and related points: A robust implementation, 15:33682 (R;XA)

Adams, T.R., *See* Cooke, D.W., 15:32693

Adamson, R.B., *See* Yang, W.J.S., 15:32583

Adar, F., *See* Robertson, J.L., 15:32718

Addagarla, S., *See* Wilk, R.D., 15:32520

Addessio, F.L., A constitutive model for the dynamic response of brittle materials, 15:33644 (J;US)

Adelman, R., *See* Bockman, R., 15:33212

Adibe, E.C., The effects of rainfall energy on soil erosion in Southern Nigeria, 15:33128 (R;XA)

Adolphsen, C.E., *See* Jung, C.K., 15:33415

See Wagner, S.R., 15:33416

See Weir, A.J., 15:33419

Aeschliman, D.P., *See* Reda, D.C., 15:32709

Afuwape, A.U., An existence theorem for periodic solutions and applications to some third order nonlinear differential equations, 15:33676 (R;XA)

Uniform dissipative solutions for some fourth order nonlinear differential equations, 15:33675 (R;XA)

Agarwal, G.S., *See* Vemuri, G., 15:33382

Ahlbeck, D.R., *See* Edwards, L.K., 15:32491

Ahrens, E.T., *See* Migliori, A., 15:32679

Aichinger, H.M., Utilization of the residual energy of integrated iron- and steelworks: Technical and economic limits, 15:32501 (R;GB)

Akai, K., *See* Kojima, Y., 15:32964

Akerlof, C., *See* Wagner, S.R., 15:33416

See Weir, A.J., 15:33419

Akers, D.J., *See* Norton, G.A., 15:32093

Akervoll, I., Three-dimensional permeability and fluid flow, 15:32131 (R;NO)

Akiba, Suminori, *See* Stram, D.O., 15:33227

Akimoto, Hajime, *See* Okubo, Tsutomu, 15:32373

Akinlade, O., *See* Lai, S.K., 15:32805

Akovali, Y.A., Single-particle states in ^{151}Tm and ^{151}Er: Systematics of neutron states in N=83 nuclei, 15:33551 (J;US)

Al Saleh-Mahrousseh, S., Relativistic calculation, in quantum electrodynamic, of the Compton diffusion on a bound electron, 15:33510 (R;FR;In French)

Al-Jassim, M.M., Defect reduction in MOCVD grown Si/GaAs: Fundamentals, structure, and devices, 15:32724 (BA;US)

See Blakeslee, A.E., 15:32733

Albright, P.C., *See* Chen, Z.Y., 15:33396

Albuquerque, M.P., *See* Cernicchiaro, G.R.C., 15:33003

Alcaraz, A., *See* Myongsook S. Oh, 15:32188

Alcorn, C., *See* Reden, K.F. von, 15:33417

Aldao, C.M., *See* Waddill, G.D., 15:32600

Alder-Schaller, S.E., *See* Newell, C.J., 15:33149

Alderman, C.J., Assembly of radioisotope power systems at Westinghouse Hanford Company, 15:32262 (R;US)

Aldrovandi, R., On the structure of quantum phase space, 15:33704 (R;BR)

Aleklett, K., *See* Loveland, W., 15:33555

Alemany, A., Tin-water magnetohydrodynamic electric power generator, 15:32475 (R;FR;In French)

Alemu, Y., A remark on Euclidean-domain types, 15:33697 (R;XA)

Alexander, D.J., *See* Klueh, R.L., 15:32538

Alexander, J.M., *See* Boger, J., 15:33538

Alexander, J.P., *See* Wagner, S.R., 15:33416

See Weir, A.J., 15:33419

Alexander, K.B., Au-Ge-Ni-Ti ohmic contacts on gallium arsenide, 15:32537 (R;US)

Electron microscopy of interfaces in silicon carbide whisker-reinforced alumina composites, 15:32699 (R;US)

Alexandratos, S.D., Polymer-based separations: Synthesis and application of polymers for ionic and molecular recognition: Annual performance report, August 1, 1989–July 31, 1990, 15:32702 (R;US)

Alexandreas, D.E., *See* Haines, T.J., 15:33322

Aliev, T.M., Decays D → Kev, D → K*ev, D → πev in QCD sum rules method, 15:33437 (R;XA)

Allen, C.W., *See* Liu, J.C., 15:32725

Allen, J.W., *See* Gunnarsson, O., 15:32694

Allen, R.C., *See* Haines, T.J., 15:33322

Allison, P., *See* Smith, H.V. Jr., 15:33792

Almeida, L.D., Chiral symmetry breaking in QED_3: bifurcation of the fermionic self-energy, 15:33503 (R;BR)

Alp, E.E., X-ray absorption spectroscopy: EXAFS [Extended X-ray Absorption Fine Structure] and XANES [X-ray Absorption Near Edge Structure]: A versatile tool to study atomic and electronic structure of materials, 15:33327 (R;US)

Alston, S., Nuclear-charge screening in electron capture, 15:33375 (J;US)
Alten, B., *See* Migliori, A., 15:32679
Altherr, T., Cancellation of infrared and mass singularities in the thermal di-lepton rate, 15:33505 (R;FR)
Altis, S., *See* Payne, J., 15:32168, 15:32169, 15:32170
Alton, G.D., Experimental determination of a species-dependent effect in the transverse emittances of sputter-generated negative-ion beams, 15:33640 (J;US)
High-intensity plasma-sputter heavy negative-ion source (invited), 15:32957 (J;US)
Alvarez, M., *See* Wagner, S.R., 15:33416
See Weir, A.J., 15:33419
Alvarez, S., *See* Whangbo, M.-H., 15:32803
Amano, Hikaru, Radon and its progeny at the elevated areas in Japan: Levels and risks, 15:33063 (RA;JP;In Japanese)
Amatuni, A.Ts., Nonlinear effects in plasma wake field acceleration (PWFA), 15:33781 (RA;JP)
Ambrose, W.A., *See* Ayers, W.B., 15:32106
Ameen, M.S., Characterization of $KNbO_3$ thin films deposited by ion beam sputtering using a computer-controlled rotating target holder, 15:32635 (BA;US)
Amendola, L., Stability of compactification during inflation, 15:33287 (R;US)
Amidei, D., *See* Abe, F., 15:33413, 15:33424, 15:33425
See Wagner, S.R., 15:33416
See Weir, A.J., 15:33419
Amin, M.R., *See* Talukdar, B., 15:33668
Ammann, M., Identification of tectonic disturbed zones in 2 soil gas profiles from Northern Switzerland, 15:33276 (R;CH;In German)
Ammann, W.C., *See* Shorter, R., 15:32495
Anderon, V.L., *See* Chen, T.S., 15:33788
Andersen, O.K., *See* Gunnarsson, O., 15:32694
Andersen, P.H., *See* Kampwirth, R.T., 15:32604
Anderson, D.K., *See* LaFlesh, R.C., 15:32316
Anderson, H.U., *See* Yu, Chikung J., 15:32669
Anderson, I.S., *See* Udovic, T.J., 15:32682
Anderson, L.E., *See* Wilson, B.W., 15:33259
Anderson, M.S., Experimental equations of state for calcium, strontium, and barium metals to 20 kbar from 4 to 295 K, 15:32593 (J;US)
Anderson, R.R., *See* White, C.M., 15:32107
Anderson, S.G., *See* Waddill, G.D., 15:32600
Andrews, G., Reactors for scaling-up coal bioprocessing, 15:32067 (R;US)
Andrews, S., *See* Barrett, M., 15:32329
Angelini, P., *See* Alexander, K.B., 15:32699
Angus, J.E., *See* Niemczyk, T.M., 15:33010
Anjos, J.C.C. dos, *See* Sokoloff, M.D., 15:33527
Annamalai, K., *See* Ramalingam, S.C., 15:32119
Ansaldo, E.J., Superconductivity and magnetism in $La_2CuO_{4+\delta}$ by μSR, 15:32633 (BA;US)
Antaya, T.A., *See* Lyneis, C.M., 15:32952
Antillogus, P., *See* Abe, K., 15:32978
Antoku, Shigetoshi, *See* Kato, Kazuo, 15:33604
Antonini, R., *See* Isotani, S., 15:33335
Antonsen, T.M. Jr., Microwave generation for magnetic fusion energy applications, Task A: Progress report, September 15, 1989–September 14, 1990, 15:33732 (R;US)
Microwave generation for magnetic fusion energy applications, Task B: Progress report, September 15, 1989–September 14, 1990, 15:33808 (R;US)
Microwave generation for magnetic fusion energy applications, Task C: Progress report, September 15, 1989–September 14, 1990, 15:33809 (R;US)
Aplan, F.F., *See* Chander, S., 15:32083
Apollinari, G., *See* Abe, F., 15:33413, 15:33424, 15:33425
Appel, J.A., *See* Sokoloff, M.D., 15:33527
Appelhans, A.D., *See* Dahl, D.A., 15:33361
See Delmore, J.E., 15:33362
Appignani, P., *See* Wreathall, J., 15:32420, 15:32421
Apts, C.W., *See* Crecelius, E.A., 15:33188
Arai, S., *See* Tokuda, N., 15:32923
Archer, B.J., Positron–hydrogen-atom *S*-wave coupled-channel scattering at low energies, 15:33369 (J;US)
Arendt, P.N., *See* Cooke, D.W., 15:32900
Arens, J.F., *See* Jernigan, J.G., 15:32938
Arepalli, S., Demonstration of the feasibility of laser induced fluorescence for arc jet flow diagnostics, 15:32866 (R;US)
Arinaga, M., *See* Kojima, Y., 15:32964
Arlinghaus, H.F., Laser damage studies of ZnS via neutral Zn particle emission, 15:32748 (J;US)
Armstrong, G., *See* Hamak, J., 15:32182
Armstrong, R., *See* Park, B., 15:33112
Arnett, K., Hanle effect in spectrally broadened light, 15:33380 (J;US)
Arnheim, N., *See* Cui, Xiangfeng, 15:33208
Arnold, G.W., Ion implantation and ion beam analysis of lithium niobate, 15:32657 (BA;US)
Arnold, J.R., *See* Nishiizumi, K., 15:33316
Arnold, S.D., Health and safety guide for inorganic compounds and metals used in the fabrication of superconductive alloys, 15:33234 (R;US)
Arnold, W.D., *See* Robinson, S.M., 15:32203
Arrasmith, S.R., *See* McCallum, R.W., 15:32660
Arthurs, E., *See* Windisch, D.E., 15:32732
Asano, K., *See* Kojima, Y., 15:32964
Asano, K.G., The study of drugs of abuse with an ion trap mass spectrometer, 15:33216 (BA;US)
See McLuckey, S.A., 15:32795
Asano, Tomohiro, Factors affecting passive monitoring of radon, 15:33603 (R;JP)
Asaro, M.F., *See* Wilson, R.B. Jr., 15:32050
Ascolese, M., *See* Kampwirth, R.T., 15:32604
Ascoli, G., *See* Abe, F., 15:33413, 15:33425
Ashley, P.R., *See* White, C.W., 15:32995
Ashman, C.R., *See* Nagy, B., 15:33221
Askew, T.R., *See* Leary, K.J., 15:32666
Aston, D., A summary of the results from LASS [Large Aperture Superconducting Solenoid] and the future of strange quake spectroscopy, 15:33410 (R;US)
See Abe, K., 15:32978
Atac, M., *See* Abe, F., 15:33413, 15:33424, 15:33425
Atamian, M., *See* Babcock, G.T., 15:32286
Atencio, J.H., *See* Buelow, S.J., 15:32806
Atwood, C.L., *See* Wolford, A.J., 15:32406
Atwood, D., Radiative corrections and semileptonic *B* decays, 15:33471 (J;US)
Auble, R.L., *See* Beene, J.R., 15:33554
Auchincloss, P., *See* Abe, F., 15:33413, 15:33424, 15:33425
Auciello, O., *See* Ameen, M.S., 15:32635
Auerbach, N., *See* Mordechai, S., 15:33535
Auger, G., *See* Boger, J., 15:33538
Autin, B., Plasma compensation effects with relativistic electron beams, 15:32917 (BA;US)
Autissier, L., Heat treatments influence on mechanical properties of zircaloy 4 - particular study of fatigue structures, 15:32534 (R;FR;In French)
Averback, R.S., *See* Hahn, H., 15:32624
See Smalinskas, K., 15:32541
See Vetrano, J.S., 15:32540
Averill, D., *See* Jung, C.K., 15:33415
Axetell, K., Improved emission factors for fugitive dust from Western surface-coal-mining sources. Volume 1. Sampling methodology and test results, 15:32110 (R;US)
Improved emission factors for fugitive dust from Western surface coal mining sources. Volume 2. Emission factors, 15:32111 (R;US)
Axness, C.L., *See* Sexton, F.W., 15:33853
Ayers, A.L. Jr., Offgas system particulate cleaning test and evaluation for the Process Experimental Pilot Plant, 15:32216 (R;US)
Ayers, W.B., Geologic evaluation of critical production parameters for coalbed methane resources. Part 1. San Juan Basin. Annual report, August 1988-July 1989, 15:32106 (R;US)
Ayuub, N.Y., *See* Maple, M.B., 15:32641
Azevedo, I.S., *See* Saitovitch, E.B., 15:32602

B

Babcock, G.T., Water oxidation in photosystem II: From radical chemistry to multielectron chemistry, 15:32286 (J;US)

Babicky, V., *See* Raus, J., 15:33744

Bachmann, P., Progress in post-test analyses of a 1:6 scale lined and reinforced concrete containment model, 15:32393 (RA;US)

Bacon, L.D., *See* Riley, D.J., 15:33036

Badaiec, J., *See* Vlad, M., 15:33752

See Weixelbaum, L., 15:33756

Baden, A.R., *See* Abe, F., 15:33413, 15:33424, 15:33425

See Weir, A.J., 15:33419

Baer, T., Gas-phase heats of formation of $C_7H_7^+$ isomers: M-tolyl, p-tolyl, and benzyl ions, 15:32822 (J;US)

PEPICO [photoelectron photoion coincidence] studies of ion dissociations: The structure and heats of formation of ions, molecules, and free radicals: Progress report, April 1989–March 1990, 15:32804 (R;US)

Baggett, M.J., The magnet components database system, 15:32931 (R;US)

Bai, G.R., Superconducting thin films of YBaCu oxides prepared by MOCVD, 15:32607 (R;US)

Bain, M.B., *See* Irving, J.S., 15:32277

Bajic, S.J., *See* Charalambidis, D., 15:33372

Baker, G.A., *See* Bruns, D.A., 15:33124

Baker, I., *See* Schmidt, B., 15:32586

Bakke, J.R., *See* Bjerketvedt, D., 15:32144

Bakos, J.S., *See* Hildebrandt, D., 15:33783

See Kalvin, S., 15:33755

Balachandran, U., *See* Cooper, E.A., 15:32802

See Shaked, H., 15:32688

Balagurogv, A.M., *See* Fridzon, M.B., 15:33002

Balasubramanian, K., Spectroscopic properties of 34 electronic states of zirconium dimer (Zr_2), 15:33383 (J;US)

Balazs, L.A.P., Nonperturbative self-consistent unitary loop corrections to Skyrmion masses, 15:33526 (J;US)

Baldo, P., *See* Scheuer, U., 15:32568

Baldwin, C.A., *See* Miller, L.F., 15:32338

Baldwin, G.T., Flash x-ray measurements with a time projection Compton spectrometer, 15:33009 (R;US)

See Harper-Slaboszewicz, V.J., 15:32918

Ball, R.D., The good, the bad, and the baryon, 15:33450 (R;DK)

Ballam, J., *See* Jung, C.K., 15:33415

See Weir, A.J., 15:33419

Balleyguier, P., *See* Dei-Cas, R., 15:32921

Ballot, J.L., The pion in the deuteron, 15:33573 (R;FR)

Balooch, M., *See* Abrefah, J., 15:32771

See Schildbach, M.A., 15:32716

Baltz, D.W., Unifying the object-oriented paradigm with semantic data models, 15:33838 (R;US)

Bamberger, A., *See* Abe, F., 15:33424

Ban, Syuichi, The shielding design methods of the synchrotron radiation facility, 1: Accelerator, 15:32935 (R;JP;In Japanese)

Bando, H., *See* Ericson, M., 15:33337

Bandy, B., *See* Payne, J., 15:32168, 15:32169, 15:32170

Bangerter, R.O., *See* Tobin, M.T., 15:33823

Bao, X.J., *See* James, R.B., 15:32632

Baral, S., *See* Zhao, Xiao Kang, 15:32763

Barbaro-Galtieri, A., *See* Abe, F., 15:33413, 15:33424, 15:33425

Barbe, B., *See* Riviere, J., 15:32397

Bardeen, W.A., Minimal dynamical symmetry breaking of the standard model, 15:33482 (J;US)

Bardy, J., *See* Dei-Cas, R., 15:32921

Barfknecht, A.T., Multichip packaging technology with laser-patterned interconnects, 15:32714 (R;US)

Barfuss, S., *See* Stauf, G.T., 15:32735

Barger, V., Recognizing the next heavy quark at $p\bar{p}$ colliders, 15:33452 (J;US)

Z-boson decays to heavy quarkonium, 15:33463 (J;US)

Barinaga, C.J., *See* Smith, R.D., 15:33198

Barish, B.C., *See* Jung, C.K., 15:33415

Barker, C., *See* Manowitz, B., 15:32164

Barklow, T., *See* Jung, C.K., 15:33415

Barlingay, C., Effects of zinc substitution on the electron superconductor $Nd_{1.85}Ce_{0.15}CuO_{4-\delta}$, 15:32692 (J;US)

Barnard, W.R., *See* Masser, C.C., 15:33094

Barnes, D.C., US-Japan workshop on field-reversed configurations with steady-state high-temperature fusion plasmas and the 11th US-Japan workshop on compact toroids, 15:33820 (R;US)

Barnes, P., *See* Chrien, R.E., 15:33533

Barnes, P.R., *See* Miller, D.B., 15:32434

Barnes, R.G., *See* Udovic, T.J., 15:32682

Barnes, V.E., *See* Abe, F., 15:33413, 15:33424, 15:33425

Barnett, B.A., *See* Jung, C.K., 15:33415

Barnett, D.L., *See* Beckerman, M., 15:32844, 15:32845

Barnhart, J.S., Parametric study of electrostatically charged sprays, 15:32862 (R;US)

Barr, E., Relational databases for SSC design and control, 15:32916 (BA;US)

Barrett, D., *See* Prono, D.S., 15:32912

Barrett, M., The case for coal: Evidence by the Coalfield Communities Campaign to the Hinkley Point 'C' nuclear power station inquiry, 15:32329 (R;GB)

Barrette, J., *See* Gomez del Campo, J., 15:33537

Barry, B.A., *See* Babcock, G.T., 15:32286

Barsanti, P., Maintaining leak tightness capability of Caorso BWR containment, 15:32384 (RA;US)

Barsch, G.R., *See* Cao, W., 15:33648

Bart, S., *See* Chrien, R.E., 15:33533

Bartelt, J., *See* Jung, C.K., 15:33415

Barth, F., Small hydro electric power development in the northern area, Pakistan: A mission report, 15:32276 (R;NO)

Barth, M., Modeling pulse driven antenna systems with finite differences, 15:32887 (R;US)

Bartha, G., *See* Roe, N.A., 15:33412

Bartlett, D., *See* Gondhalekar, A., 15:33776

Barut, A.O., Membranes, strings, extended elementary particles as singularities of fields, 15:33488 (R;XA)

Basaran, O.A., Drop oscillations in liquid-liquid systems, 15:32872 (J;US)

Baskes, M.I., *See* Hoagland, R.G., 15:32587

Bassalleck, B., *See* Chrien, R.E., 15:33533

Bastrukov, S.I., Fluid-dynamics of the nuclear surface Fermi-layer, 15:33576 (R;HU)

Time evolution of the mass exchange in grazing heavy-ion collisions, 15:33341 (R;HU)

Basu, S.N., *See* Halloran, J.W., 15:32616

Bates, J.K., *See* Abrajano, T.A., 15:32727

Battle, P.D., High-pressure phase transitions in the 6H perovskites $Ba_3MSb_2O_9$ (M = Mg, Ni, Zn), 15:32667 (J;US)

Bauer, J.S., *See* Vineyard, M.F., 15:33534

Baughman, R.J., *See* Halloran, J.W., 15:32616

Baune, W.K., *See* Kapustka, L.A., 15:33250

Baur, U., Probing the $WW\gamma$ vertex at the Fermilab Tevatron Collider, 15:33422 (J;US)

Bausch, M.J., Studies of the energetics of C-S bond-breaking reactions in radical ions derived from coal model compounds, 15:32084 (RA;US)

Baw, J.I., 3-D FEM analysis of 1:6 scale reinforced concrete containment under static overpressurization and local analysis of liner plant tearing, 15:32401 (RA;US)

Baxi, A.H., *See* Rizzo, H.F., 15:32569

Baxter, D.J., PCGPAK for message passing multiprocessors. Final report on Phase 1, 15:33851 (R;US)

Solving large sparse linear systems of equations in a global shared-memory multiprocessing environment. Final report on Phase 1, 15:33852 (R;US)

Bayne, C.K., Multilaboratory validation study of PCBs in soils using Soxtec® extraction technique (Method 3541), 15:33119 (R;US)

Beall, C., Detecting leaks: Successful methods step-by-step. Final report, 15:32162 (R;US)

Beaudry, B.J., Preparation, fabrication and properties of a rare earth intermetallic compound - GdPd: Extraction preparation and applications, 15:32644 (BA;US)

Process variables in the preparation of high purity rare earth metals: Extraction preparation and applications, 15:32799 (BA;US)

Beausang, C.W., *See* Becker, J.A., 15:33558

Becher, P.F., *See* Alexander, K.B., 15:32699
Becherrawy, T., *See* Altherr, T., 15:33505
Bechtold, W.E., Inhalation Toxicology Research Institute annual report, October 1, 1988–September 30, 1989, 15:33224 (R;US)
See Mewhinney, J.A., 15:33223
Beck, C., *See* Vineyard, M.F., 15:33534
Beck, D.H., *See* Reden, K.F. von, 15:33417
Becker, D., *See* Mayer, R., 15:32982
Becker, H., Repercussion of the production of renewable resources on foodstuff supply and appraisal of policy measures for promoting the production of renewable resources, 15:32268 (R;DE;In German)
Becker, J.A., Observation of superdeformation in ^{192}Hg, 15:33558 (J;US)
See Mach, H., 15:33543
See Warburton, E.K., 15:33591
Becker, J.F., *See* Pferdehirt, W., 15:33165
Becker, R.H., *See* Fesen, R.A., 15:33319
Beckerman, M., Performance of multiple tasks by an autonomous robot using visual and ultrasound sensing, 15:32845 (R;US)
Ultrasound and visual sensor feedback and fusion, 15:32844 (R;US)
Bedeschi, F., *See* Abe, F., 15:33413, 15:33424, 15:33425
Bedford, R.G., *See* Violet, C.E., 15:32663
Bediaga, I., Hadron production in a fireball radiation model for electron-positron collisions, 15:33428 (R;BR)
Beegle, J.E., *See* Datta, B., 15:33171
Beene, J.R., Heavy-ion Coulomb excitation and photon decay of the giant dipole resonance in ^{208}Pb, 15:33554 (J;US)
Beery, J.G., *See* Cooke, D.W., 15:32900
Begeal, D.R., Titanium-boron mixtures as variable heat sources, 15:32437 (R;US)
Beier, G., Excitation-energy sharing in uranium induced dissipative collisions, 15:33540 (R;DE)
Belanger, D.W., Interpretation of hydraulic testing in the sediments of the Riniken borehole, 15:33268 (R;CH)
Interpretation of hydraulic testing in crystalline rock at the Leuggern borehole, 15:33269 (R;CH)
Belhadj, M., Theoretical analysis of resonance Raman spectra from the blue copper protein azurin, 15:33202 (J;US)
Belkacem, A., High-resolution study of dielectronic capture by channeled Ti ions, 15:33635 (J;US)
Bell, B., Datum definition problems in accelerator alignment, 15:32910 (R;US)
Bell, G.L., *See* Isler, R.C., 15:33806
Bell, P.M., Multiframe x-ray images from a single meander stripline coated on a microchannel plate, 15:32979 (R;US)
Bello, J., *See* Johnson, R.W., 15:32793
Bello, J.M., In situ surface-enhanced Raman spectroscopy using new TiO2 based substrates, 15:32796 (BA;US)
Belmont, J.L., News developments at Sara, 15:32908 (R;FR)
Belyaev, V.M., Higher loop contributions to effective potential of gauge theory at high temperature, 15:33487 (R;XA)
Bench, T.R., Method and apparatus for the in situ decontamination of underground water with the aid of solar energy, 15:33191 (P;US)
Benedek, R., Positron-annihilation momentum density in superconductors, 15:33657 (J;US)
Bengtsson, Tord, Diabatic orbitals in nuclear structure, 15:33578 (R;SE)
Bennett, B.L., *See* Cooke, D.W., 15:32900
Bennett, C.A., *See* Hutchinson, D.P., 15:33723
Bennett, D.P., *See* Bouchet, F.R., 15:33324
Bennett, E.F., *See* Chiu, H.K., 15:33804
Beno, M.A., *See* Whangbo, M.-H., 15:32803
Benoit, J., *See* Hemond, H.F., 15:33173
Bentley, J., *See* Horton, J.A., 15:32560
Berdermann, E., *See* Milkau, U., 15:33552
Berg, P., Simulation of thermal conditions in a solar heating system with seasonal storage, 15:32293 (R;DK;In Danish)
Bergeman, T., *See* Arnett, K., 15:33380
Berger, E.L., *See* Baur, U., 15:33422
Berkhout, F. F., *See* Barrett, M., 15:32329
Berkin, A.L., Soft inflation, 15:33288 (R;US)
Berkner, K.H., *See* Belkacem, A., 15:33635
Berley, D., *See* Haines, T.J., 15:33322
Bern, Z., Open superstrings in four dimensions, 15:33520 (J;US)
Bernard, V., Higher-order corrections to the scalar quark density in the proton, 15:33457 (J;US)
Bernasconi, A., *See* Felder, E., 15:32581
Bernier, P., *See* Ma, J., 15:32768
Bernstein, A.M., *See* Reden, K.F. von, 15:33417
Bernstein, E.M., Enhanced radiative Auger emission from lithium-like $_{16}S^{13+}$, 15:33381 (J;US)
See Belkacem, A., 15:33635
Bernstein, I.M., *See* Stevens, M.F., 15:32590
Bernstein, J., Aspects of the Zel'dovich-Sunyaev mechanism, 15:33318 (J;US)
Bertini, R., Spin observables in antip-N elastic scattering, 15:33399 (R;FR)
Bertrand, F.E., *See* Beene, J.R., 15:33554
Bertucio, R.C., Analysis of core damage frequency: Surry, Unit 1 internal events: Volume 3, Revision 1, Part 1, 15:32414 (R;US)
Analysis of core damage frequency, Surry, Unit 1 internal events appendices: Volume 3, Revision 1, Part 2, 15:32415 (R;US)
Beskid, N.J., *See* Devgun, J.S., 15:32253
Betzel, C., *See* Hingerty, B., 15:33200
Beulertz, W., Development of a large-area scintillation detector with good spatial resolution, 15:32968 (R;DE;In German)
Beutler, D.E., Dosimetry considerations for the high-energy photon/electron environment of HERMES III: Implications for experiments and modeling, 15:32937 (R;US)
Bhalla, C.P., Angular distribution of Auger electrons and photons in resonant transfer and excitation in collisions of ions with light targets, 15:33364 (J;US)
Autoionization rates for selected double-Rydberg states of barium, 15:33376 (J;US)
Bhatnagar, V.P., JET ICRH antenna for pumped-divertor geometry: Workshop held at JET on 25/26 September 1989, 15:33774 (RA;GB)
Bhattacharjee, P., Ultrahigh-energy particle flux from cosmic strings, 15:33290 (R;US)
Bhattacharya, P., *See* Chang, K., 15:32772
Bi0rnholm, T., *See* Maple, M.B., 15:32641
Bibler, N.E., Radiation effects in silicate glasses: A review, 15:32728 (BA;US)
Bickes, R.W. Jr., A transformer coupled semiconductor bridge igniter for low voltage ignition from a high voltage source, 15:33025 (R;US)
Bicknell, R., Health-hazard evaluation report HETA 87-075-1988, American Cyanamid, Wallingford, Connecticut, 15:33074 (R;US)
Biefeld, R.M., Improving the performance of $InAs_{1-x}Sb_x$/InSb infrared detectors grown by metal organic chemical vapor deposition, 15:32711 (R;US)
Bienz, T., *See* Abe, K., 15:32978
See Aston, D., 15:33410
Bier, Th., *See* Hahn, H., 15:32624
Bierman, S.R., Criticality experiments with neutron flux traps containing voids, 15:32198 (R;US)
Bigelow, T.S., *See* Isler, R.C., 15:33806
Biller, S., *See* Haines, T.J., 15:33322
Billerey, J., Solar powered pumping systems. Existing material, cost of a cubic meter, comparison with other pumping systems, maintenance, appendix, 15:32288 (R;FR;In French)
Billquist, P.J., *See* Pardo, R.C., 15:32928
Binning, R.C. Jr., Theoretical study of GeH_n, AsH_n, and SeH_n: Ionization energies, 15:33384 (J;US)
Bird, F., *See* Abe, K., 15:32978
Bird, T., *See* Aston, D., 15:33410
Birge, R.R., *See* Stauf, G.T., 15:32735
Birtcher, R.C., *See* Liu, A.S., 15:32730
Bishop, C.E., *See* Blackett, R.E., 15:32295
Bishop, D.J., Behavior of phenol and aniline on selected sorbents and energy-related solid wastes, 15:32081 (J;NL)
Bisol, A.K., Recurrence relations and weight functions for approximation by orthonormal polynomials, 15:33680 (R;XA)
Biswas, A., *See* Park, B., 15:33112
Biswas, R., *See* Kwon, I., 15:32773
Bixby, W.W., *See* McIntosh, T.W., 15:32247

Bjerketvedt, D., Literature review of work related to impact of barriers on flammable cloud explosion overpressure: Vapor Barrier Assessment Program, Phase 2, Task 1, 15:32144 (R;US)
Numerical simulation of hypothetical gas explosions in a process unit: Effect of vapor barriers on explosion pressure, 15:32146 (R;US)
Bjerstedt, T.W., Trace fossils and bioturbation in peritidal facies of the Potsdam-Theresa Formations (Cambrian-Ordovician), Northwest Adirondacks, 15:33281 (J;US)
Bjornstad, B.N., Geohydrology of the 218-W-5 Burial Ground, 200-West Area, Hanford Site, 15:32231 (R;US)
Blachot, J., Fission product measurement methods. Present state of knowledge, 15:33565 (R;FR;In French)
Blackbourn, R.L., Does Marcus-Hush theory really work? Optical studies of intervalence transfer in acetylene-bridged biferrocene monocation at infinite dilution and at finite ionic strengths, 15:32826 (J;US)
Blackett, R.E., The Newcastle geothermal system, Iron County, Utah: Geology, hydrology, and conceptual model, Volume 1: Final report, 15:32295 (R;US)
Blackwell, B.D., Electron beam measurements in SHEILA using a simple method of image intensification, 15:33727 (RA;AU)
Experimental studies on drift waves in SHEILA, 15:33729 (RA;AU)
ICH system for Heliac H1, 15:33726 (RA;AU)
Vacuum field optimization and the effects of field errors on the flux surfaces of the H-1 Heliac, 15:33803 (RA;AU)
See Conway, G.D., 15:33725
See Hamberger, S.M., 15:33724
Blaesi, H.R., *See* Peters, Tj., 15:33263, 15:33264
Blair, D.S., *See* Rogers, J.W., 15:32639
Blair, D.S., Nelson, G.C, *See* Peden, C.H.F., Rogers, J.W., 15:32800
Blak, A.R., *See* Isotani, S., 15:33335
Blakely, J.M., *See* Shen, Q., 15:32588
Blakeslee, A.E., GaP/Si heteroepitaxial layers with reduced defect density: Fundamentals, structure, and devices, 15:32733 (BA;US)
Blankenship, R.E., *See* Trost, J.T., 15:32287
Blankleider, B., *See* Nozawa, S., 15:33581
Blann, M., *See* Reffo, G., 15:33588
Blattner, M.M., Listening to turbulence: An example of scientific audiolization, 15:33388 (R;US)
Bleackley, M.H., Some post-test analyses of the 1/6th Sandia containment, 15:32396 (RA;US)
Bledsoe, B.E., *See* Huling, S.G., 15:32157
See Powell, R.M., 15:33170
Blessing, S., *See* Sambamurti, A., 15:33418
Bliss, D.E., Absolute pressure dependence of the second ionization level of EL2 in GaAs, 15:32755 (J;US)
Blockus, D., *See* Abachi, S., 15:33420
Blomqvist, K.I., *See* Reden, K.F. von, 15:33417
Blossom, J.W., Minerals yearbook, 1988. Molybdenum, 15:32458 (R;US)
Blum, L., A general solution of the molecular Ornstein–Zernike equation for spheres with anisotropic adhesion and electric multipoles, 15:33397 (J;US)
Blumberg, L.N., Orbit calculations and lattice parameters for the BNL [Brookhaven National Laboratory] SXLS [Superconducting X-Ray Lithography Source]: Part 2, Betatron functions in the superconducting bending magnet and synchrotron radiation integrals, 15:32920 (R;US)
Blumenthal, D.L., *See* Hering, S.V., 15:33093
Blundell, S.A., Improved many-body perturbation theory calculations of the n=2 states of lithiumlike uranium, 15:33374 (J;US)
Boag, N.M., *See* Stauf, G.T., 15:32735
Boatner, L.A., Monazite, 15:32246 (BA;US)
See Feenstra, R., 15:32653
See Sokoloff, J.P., 15:32764
Bockman, R., Gallium a unique anti-resorptive agent in bone: Preclinical studies on its mechanisms of action, 15:33212 (R;US)
Bocquet, J.P., *See* Blachot, J., 15:33565
Bodek, A., *See* Whitlow, L.W., 15:33433
Boehm, R.F., Direct-contact heat transfer processes, 15:32292 (BA;US)
Boekema, C., *See* Cooke, D.W., 15:32693
Boger, J., Three paths for intermediate-mass fragment formation at a near-onset excitation energy of 1.3 MeV/nucleon, 15:33538 (J;US)
Bohanon, T.M., Determination of lattice structure and calculation of molecular tilt in lipid monolayers on water using x-ray diffraction, 15:32777 (J;US)
Bohlke, J.K., *See* Abrajano, T.A., 15:32727
Bohr, J., *See* D'Amico, K.L., 15:32776
Boiteaux, P.J., *See* Floch, H.G., 15:32532
Bokhari, A.H., A comment on anisotropic spheres admitting one parameter group of conformal motions, 15:33671 (R;XA)
Bolch, W.E., *See* Yoshida, H., 15:33231
Bollenbacher, M.K., *See* Nielson, K.K., 15:33140
Bollini, C.G., Gauge transformations for six dimensional superfields, 15:33474 (R;BR)
Higher order equations of motion, 15:33430 (R;BR)
Bollman, M.A., *See* Kapustka, L.A., 15:33250
Bolt, H.H., *See* Niemer, K.A., 15:33822
Bonekamp, J., The calculation of the quark distribution amplitude of the $\Delta^{3/2+}(1232)$ respectively the $\Delta^{1/2-}(1600)$ by means of the QCD sum rules for the determination of the N→Δ transition form factor at $Q^2 \simeq 10$ GeV^2, 15:33426 (R;DE;In German)
Bonner, R., *See* Bell, P.M., 15:32979
Bonzon, C.J., Buried waste program at the Idaho National Engineering Laboratory, 15:32249 (BA;US)
Booth, M.J., Interpretation of the neutron electric dipole moment: Possible relationship to $|\epsilon'|$, 15:33456 (J;US)
Bordeaux, L., *See* Von Schweber, E., 15:33857
Border, P., *See* James, C., 15:33414
Borghese, J.V., *See* Gilmore, T.J., 15:32232
Borowski, K., *See* Squillante, M.R., 15:32260
Bos, R., *See* Holland, R.F., 15:33378
Boston, H.L., Evaluating direct toxicity and food-chain effects in aquatic systems using natural periphyton communities, 15:33139 (R;US)
Bottcher, C., *See* Griffin, D.C., 15:33328
See Pindzola, M.S., 15:33358, 15:33370
See Strayer, M.R., 15:33593
Bottrell, G.J., *See* Pindzola, M.S., 15:33358
Bouchet, F.R., Millisecond-pulsar constraint on cosmic strings, 15:33324 (J;US)
Bourke, R.C., Reduction of ash sticking in direct coal-fired gas turbine engines, 15:32120 (BA;US)
Bouziane, A., Contribution to the analytical and numerical evaluation of oil well equilibrium for any cross section under a uniform pressure and an anisotropic stress field, 15:32130 (R;FR;In French)
Bowles, E., *See* Prono, D.S., 15:32912
Bowles, E.E., Induction linac energy regulation via injector current modulation, 15:32940 (R;US)
Bowman, M.K., *See* Isoya, J., 15:32775
Bowser, J.J., *See* Edgerton, E.S., 15:33092
Boyack, B.E., *See* Wilson, G.E., 15:32360
Boyce, J.B., *See* Fork, D.K., 15:32631
Boyd, J.K., *See* Fawley, W.M., 15:32926
Boyd, S.T.P., New mode of growth of ^{3}He-*B* in hypercooled ^{3}He-*A*: Evidence of a spin supercurrent, 15:33394 (J;US)
Boyes, J.D., Engineering design of the Saturn accelerator, 15:32945 (BA;US)
Boyko, V.G., Mini-inflation prior to the cosmic confinement transition, 15:33296 (R;HU)
Boyns, P.K., An aerial radiological survey of the United States Department of Energy's Rocky Flats Plant, Golden, Colorado: Date of survey, July 1989, 15:33057 (R;US)
Brabson, B., *See* Abachi, S., 15:33420
Bradbury, M.H., Grimsel test site: laboratory investigations in support of the migration experiments, 15:32222 (R;CH)
Bradley, D.K., *See* Bell, P.M., 15:32979
Bradley, M.M., Numerical simulation of aerosol scavenging by ice-bearing convective clouds, 15:33104 (R;US)
See Molenkamp, C.R., 15:33105
Bradt, R.C., *See* Ghosh, A., 15:32652
Brady, M.C., Delayed neutron data and group parameters for 43 fissioning systems, 15:32334 (J;US)

Braeuer, V., Grimsel test site: engineering geological investigations into the interpretation of rock stress measurements and fracture system flow tests, 15:32224 (R;CH;In German)
See Pahl, A., 15:33274
Braginsky, V.B., Propagation of electromagnetic radiation in a random field of gravitational waves and space radio interferometry, 15:33673 (R;XA)
Braicovich, L., Valence photoelectron spectroscopy of Gd silicides, 15:32769 (J;US)
Brainard, J.R., Ordered synthesis and mobilization of glycogen in the perfused heart, 15:33205 (J;US)
Brant, S., *See* Meyer, R.A., 15:33547
Bratko, D., *See* Blum, L., 15:33397
Braun, R.L., *See* Burnham, A.K., 15:32166
Bray, K.L., Piezochromism: Pressure-induced isomerizations in the tetrachlorocuprate anion in the solid state with various cations, 15:32592 (J;US)
Bray, K.N.C., *See* Cant, R.S., 15:32861
Bredy, P., Study of a magnetic refrigeration cycle by active regeneration between 15 and 4.2 kelvins, 15:32864 (R;FR;In French)
Breiland, W.G., *See* Ho, P., 15:32638
Brennan, E.C., Physics at the 100 GeV mass scale: Proceedings, 15:33398 (R;US)
Brennan, S., *See* Fuoss, P.H., 15:32721
Brennan, T.M., *See* Carson, R.F., 15:33043
Brennan, G.M., *See* Williams, M.D., 15:33349
Brenner, H., *See* Abbott, J.R., 15:33632
Brenner, R.P., Borehole sealing: conceptual design and feasibility study, 15:32226 (R;CH;In German)
Breuer, H., *See* Kwiatkowski, K., 15:33550
See Planeta, R., 15:33549
Brewer, H.D., *See* Davis, G.A., 15:32379
Brewer, J.H., *See* Ansaldo, E.J., 15:32633
Brezowski, C.F., *See* Evans, N.A., 15:32871
Bridges, F., *See* Fork, D.K., 15:32631
Briere, R.A., *See* Booth, M.J., 15:33456
Bringans, R.D., *See* Olmstead, M.A., 15:32736
Brinker, C.J., *See* Hietala, S.L., 15:32615
Brinkman, M.J., *See* Becker, J.A., 15:33558
Brinson, M.M., Strategies for assessing the cumulative effects of wetland alteration on water quality, 15:33172 (R;US)
Brissot, R., *See* Blachot, J., 15:33565
Britten, J.A., A numerical study of silane combustion, 15:32836 (R;US)
Broadhead, B.L., QADS: A multidimensional point kernel analysis module, 15:33596 (R;US)
Brock, J.R., *See* Seo, Y., 15:33091
Brockelsby, H.C. Jr., Computer-aided engineering annual report for calendar year 1989, 15:33845 (R;US)
Brockenbrough, J.R., *See* Suresh, S., 15:32608
Brody, L., *See* Bockman, R., 15:33212
Brom, J., *See* Abachi, S., 15:33420
Brookins, D.G., Revised Eh-pH diagrams (25 C, one bar) for uranium and transuranic elements: Application to radioactive waste studies, 15:32809 (BA;US)
Brooks, G.W., Air Emissions Species Manual. Volume 2. Particulate-matter Species Profiles. Second edition. Final report, April 1988-October 1989, 15:33083 (R;US)
Air-Emissions-Species Manual. Volume 1. Volatile-organic-compound species profiles. Second edition. Final report, April 1988-October 1989, 15:33087 (R;US)
Brown, B.A., *See* Warburton, E.K., 15:33591
Brown, C.W., IPPEX [Inspection Process Planning EXpert]: An automated planning system for dimensional inspection, 15:33848 (R;US)
Brown, I.G., Broad-beam multi-ampere metal ion source, 15:33353 (J;US)
Cathode erosion rates in vacuum-arc discharges–, 15:33831 (J;US)
See Sasaki, J., 15:33354
See Shiraishi, H., 15:33355
See Vandentop, G.J., 15:32770
Brown, M.A., *See* Deonigi, D.E., 15:32467
Brown, N.J., *See* Martin, R.J., 15:32838
Brown, R.D., Radiation effects in magnetic and superconducting materials, 15:32665 (J;US)
Brown, S.D., Studies of the analyte-carrier interface in flow injection analysis: Project report, June 1, 1987–December 1, 1989, 15:32784 (R;US)
Brown, S.E., *See* Migliori, A., 15:32679
Brown, V.R., The nucleon-nucleon interaction in the presence of the electromagnetic field: Nucleon-nucleon bremsstrahlung, 15:33451 (R;US)
Browne, C.L., Air toxics compliance issues and case histories from the Kentucky experience, 15:32450 (BA;US)
Browner, R.F., Fundamental studies with a monodisperse aerosol-based liquid chromatography/mass spectrometry interface (MAGIC-LC/MS): Progress report, September 1, 1985–November 30, 1989, 15:32783 (R;US)
Bruhn, D.F., *See* Ward, T.E., 15:32077
Brule, J.E., *See* Minh, N.O., 15:32477
Brumbach, S.B., Experiments and analysis for large conventional fast reactors in ZPPR-18/19, 15:32326 (R;US)
Bruns, D.A., Integrated environmental monitoring at remote ecosystems: First annual report, 15:33124 (R;US)
Brusasco, R.M., *See* Floch, H.G., 15:32532
Bruynooghe, M., *See* Mulkers, A., 15:33843
Bryan, R.P., Temperature dependence of compositional disordering of GaAs-AlAs superlattices during MeV Kr irradiation, 15:32774 (J;US)
Bryant, F.O., Dechlorination of pentachlorophenol, 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid in anaerobic freshwater sediments, 15:33148 (R;US)
Bu, Y., The ionization of thermal and hyperthermal beams of Na, K, and Cs on Si(111) surfaces, 15:33646 (J;US)
Buchal, C., *See* White, C.W., 15:32995
Buchanan, M.V., *See* Wise, M.B., 15:33050
Buck, P., Relativistically covariant projection formalism for an interacting quantum field theory, 15:33484 (R;DE)
Budal, J.D., *See* Feenstra, R., 15:32653
Budhani, R.C., *See* Williams, G.P., 15:32691
Buelow, S.J., Destruction of propellant components in supercritical water, 15:32806 (R;US)
Buerger, G., *See* Kalvin, S., 15:33755
Buescher, M., Coexistence features in the spherical-deformed $A \approx 100$ transition region: Picosecond lifetime measurements in ^{97}Sr, ^{97}Y, and ^{97}Zr, 15:33545 (J;US)
Bui, T.X., Effects of internal hydrogen on the vacancy loop formation probability in Al, 15:32539 (R;US)
Buletti, M., *See* Keusen, H.R., 15:33267
Bulgac, A., *See* Walet, N.R., 15:33585
Bullock, J.S. IV, *See* Hutchinson, D.P., 15:33723
Bulmer, D., *See* Ward, T.E., 15:32077
Bunker, B.C., *See* Voigt, J.A., 15:32898
Bunker, S., *See* Yamada, T., 15:33061
Buratti, M.F., Study of axial mixing phenomena in pulse columns equipped with crown-disk packing, 15:32196 (R;FR;In French)
Burcat, A., Shock tube ignition of isomers of octane, 15:32167 (R;US)
Burgdoerfer, J., Convoy electrons, 15:33616 (R;US)
See Lencinas, S., 15:33597
Burke, A.F., Application of ultracapacitors in electric vehicle propulsion systems, 15:32523 (R;US)
Burke, D.L., *See* Roe, N.A., 15:33412
Burkhardt, G.L., *See* Fisher, J.L., 15:32337
Burks, B.L., *See* Beene, J.R., 15:33554
Burlein, M., *See* Mordechai, S., 15:33535
Burlile, G., *See* Wreathall, J., 15:32420, 15:32421
Burman, R.L., *See* Haines, T.J., 15:33322
Burnham, A.K., Comparison of isothermal and nonisothermal pyrolysis data with various rate mechanisms: Implications for kerogen structure, 15:32166 (BA;US)
Energy and Technology Review, March 1990, 15:32529 (R;US)
Burns, D.R., *See* Williams, M.D., 15:33349
Burr, G.A., *See* Matte, T.D., 15:33075, 15:33239
Burton, J.W., Fermion loops in the effective potential of N = 1 supergravity, with application to no-scale models, 15:33506 (R;US)
Buss, R.J., *See* Ho, P., 15:32638
Bussac, M.N., *See* White, R.B., 15:33793

Butkovich, T.R., *See* Heuze, F.E., 15:33039
Butler, G.A., Interpretation of hydraulic testing at the Weiach borehole, 15:33270 (R;CH)
Butler, W.A., *See* Brooks, G.W., 15:33083, 15:33087
Butler, W.H., Validity and accuracy of multiple-scattering theory, 15:33643 (J;US)
Butterfield, C.P., Aerodynamic pressure measurements on a rotating wind turbine blade, 15:32306 (R;US)
Buttermore, W.H., *See* Norton, G.A., 15:32093
Byers, C.H., *See* Basaran, O.A., 15:32872
See Robinson, S.M., 15:32203

C

Cable, G.D., Using the XPATHS computer code, 15:32855 (R;US)
Cable, J.W., [Neutron scattering studies of spatial correlations in Fe-V and Fe-Cr alloys]: Foreign trip report, September 30, 1989–April 23, 1990, 15:32554 (R;US)
Cabo, A., On Dirac's conjecture for Hamiltonian systems with first and second class constraints, 15:33485 (R;XA)
Cadwallader, L.C., Current US efforts in fusion failure experience data, 15:33813 (R;US)
Cady, D.R., *See* Haines, T.J., 15:33322
Caffee, M.W., *See* Davis, J.C., 15:32941
See Southon, J.R., 15:32942
Cahn, R.N., Elastic scattering and total cross sections, 15:33407 (R;US)
Two-photon physics, 15:33406 (R;US)
Cai, A., *See* Patt, B.E., 15:32973
Cai, W., Resonance of the one-dimensional electron transmission above a quantum well with dissipation, 15:33645 (J;US)
Calarco, J.R., *See* Countryman, P.J., 15:33561
Calaway, W.F., *See* Arlinghaus, H.F., 15:32748
Caldeira, A.O., *See* Cerdeira, H.A., 15:33674
Caldwell, W.M., *See* Tomkins, B.A., 15:33256
Calle, L.M., Study of metal corrosion using ac impedance techniques in the STS launch environment, 15:32549 (RA;US)
Campbell, C.S., Mechanics/heat-transfer relation for particulate materials: Quarterly report, 15:32114 (R;US)
Campbell, D.L., Estimation of emissions from charcoal lighter fluid and review of alternatives. Final report, 15:33088 (R;US)
Campbell, M.D., Field Lysimeter Test Facility: Second year (FY 1989) test results, 15:32228 (R;US)
Canavan, G.H., Economics of nonrenewable energy resources, 15:32453 (R;US)
Exchange ratios for singlet boost-phase defenders, 15:33040 (R;US)
Canfield, P.C., Unifying trends found for the $V_N O_{2N-1}$ series by the application of hydrostatic pressure, 15:32695 (J;US)
Cann, D., *See* Sarkar, V., 15:33854
Cannas, S.A., A generalised Hubbard Hamiltonian: influence of temperature and fractality, 15:33610 (R;BR)
Cannon, P., *See* Kaufmann, E.N., 15:33656
Cant, R.S., Modelling of flamelet surface-to-volume ratio in turbulent premixed combustion, 15:32861 (R;US)
Cantor, C.R., *See* Doggett, N.A., 15:33210
Cao, W., Landau-Ginzburg model of interphase boundaries in improper ferroelastic Perovskites of D_{4h}^{18} symmetry, 15:33648 (J;US)
Cap, J.S., *See* Boyes, J.D., 15:32945
Capasso, C., *See* Waddill, G.D., 15:32600
Capone, D.W., *See* Ledbetter, H.M., 15:32892
Caporaso, G.J., *See* Fawley, W.M., 15:32926
See Prono, D.S., 15:32912
Caprasse, H., *See* Demaret, J., 15:33521
Carboneau, M.L., Highlights of the OECD [Organization for Economic Cooperation and Development] LOFT [Loss-of-Fluid Test] LP-FP-2 experiment including hydrogen generation, fission product chemistry, and transient fission product release fractions, 15:32346 (R;US)
Carcassi, M., Containment loading by deliberate ignition of flammable gas mixtures, 15:32381 (RA;US)
Carchano, R., Amorphous GaAs thin layers, 15:32283 (R;FR;In French)
Cardenas, R., *See* Taranko, R., 15:33625
Carey, G.P., *See* Wahi, A.K., 15:32757
Carey, J.W., *See* Marvin, U.B., 15:33283
Carim, A.H., *See* Tuttle, B.A., 15:32712
Carley, J., *See* von Holtz, E., 15:33032
Carlson, G.A., *See* Harper-Slaboszewicz, V.J., 15:32918
Carlson, N.M., Sensing of metal-transfer mode for process control of GMAW [gas metal arc welding], 15:32848 (R;US)
Carnasciali, F., *See* Carcassi, M., 15:32381
Carneiro, C.E.I., On the ζ-function regularization of chiral Jacobians for singular Dirac operators, 15:33663 (R;BR)
Carnes, J., Defense Energy Information System (DEIS). Directive, 15:33861 (R;US)
Carpenter, M.S., *See* Melloch, M.R., 15:32753
Carpenter, R.W., *See* Kim, M.J., 15:32745
Carpenter, S.G., *See* Brumbach, S.B., 15:32326
Carr, G.L., *See* Williams, G.P., 15:32691
Carr, M.J., *See* Reno, J.L., 15:32754
Carr, W.E., *See* Souzis, A.E., 15:33363
Carroll, C.E., Analytic solution of the two-state problem, 15:33718 (J;US)
Carroll, R.D., Electric logging and electrical properties of rocks in Rainier Mesa area, Nevada Test Site, Nevada, 15:32717 (R;US)
Carroll, S.M., Limits on a Lorentz- and parity-violating modification of electrodynamics, 15:33524 (J;US)
Carson, L., Approximate computation of the small-fluctuation determinant around a sphaleron, 15:33517 (J;US)
Carson, R.F., A new technique for hardening optically-triggered thyristors, 15:33043 (R;US)
Carter, C.B., High-resolution microscopy of ceramics, 15:32634 (BA;US)
Carter, R.J., Human factors survey of advanced instrumentation and controls, 15:32409 (RA;US)
Casada, D.A., Aging assessment of auxiliary feedwater systems, 15:32411 (RA;US)
Casey, C., *See* Loveland, W., 15:33555
Cass, G.R., *See* Hildemann, L.M., 15:33047
Casten, R.F., *See* Buescher, M., 15:33545
See Mach, H., 15:33543, 15:33546
Castro, T.T.M. de, *See* Isotani, S., 15:33335
Cauffman, T.L., *See* Belanger, D.W., 15:33268
See Butler, G.A., 15:33270
Causey, R.A., *See* Wampler, W.R., 15:32710
Cavagnero, M., Two-body fragmentation channels of three-body systems, 15:33367 (J;US)
Cavalcante, J.T.P.D., *See* Souza, J.H., 15:33004
Cederwall, R.T., *See* Rodriguez, D.J., 15:33109
Celik, I., Trend analysis of coal gasification product yields in an entrained flow reactor: Final report, 15:32047 (R;US)
Cena, R., Oil shale quarterly report, April–December 1989, 15:32186 (R;US)
Centanaro, C., Development of a hydrogen mitigation strategy for degraded core accidents in a BWR/6 - Mark III power plant, 15:32385 (RA;US)
Cerdeira, H.A., Dissipative quantum maps, 15:33672 (R;XA)
Quantum chaos and dissipation: Lyapunov exponents, 15:33674 (R;XA)
Cerezo, A., Morphological and structural characterization of the spinodal decomposition of Fe-Cr alloys, 15:32536 (R;US)
Cerjan, C., Variable time-step integrator for intense field dynamics, 15:33359 (J;US)
Cernansky, N.P., *See* Wilk, R.D., 15:32520, 15:32789
Cernicchiaro, G.R.C., S100 lathe bed pulse generator applied to pulsed nuclear magnetic resonance, 15:33003 (R;BR;In Portuguese)
See Souza, J.H., 15:33004
Cerny, B.A., Development of an Integrated Record Input System (IRIS) for DOE's Technical Information Center, 15:33858 (R;US)
Cerritelli, S., DpnA, a methylase for single-strand DNA in the Dpn II restriction system, and its biological function, 15:33203 (J;US)
Cerruti, C., *See* Eckert, E.M., 15:33559
Chaban, E.E., *See* Ma, Y., 15:32601

Chakraborty, R., Description and validation of a method for simultaneous estimation of effective population size and mutation rate from human population data, 15:33209 (J;US)
Chambers, F.W., *See* Fawley, W.M., 15:32926
Champney, P., *See* Curry, R.D., 15:33827
Chan, C.T., Comment on "Observation and structural determination of $\sqrt{3}\times\sqrt{3}$ $R30°$ reconstruction of the Si(111) surface", 15:32747 (J;US)
Chander, S., Enhancement of surface properties for coal beneficiation: Technical progress report, January 1, 1990–March 31, 1990, 15:32083 (R;US)
Chang Zhe, Operator formalism of multi-pole Virasoro algebra on Riemann sphere, 15:33498 (R;XA)
Chang, C.Y., *See* Haines, T.J., 15:33322
See Hong, J.W., 15:32744
Chang, D., *See* Shih, I., 15:32997
Chang, H.L.M., Ceramic epitaxial films and multilayers prepared by MOCVD, 15:32606 (R;US)
See Bai, G.R., 15:32607
Chang, J.P., *See* Shen, Q., 15:32588
Chang, K., Lattice-mismatched $In_{0.53}Ga_{0.47}As/In_{0.52}Al_{0.48}As$ modulation-doped field-effect transistors on GaAs: Molecular-beam epitaxial growth and device performance, 15:32772 (J;US)
Chang, W.S.C., *See* White, C.W., 15:32995
Chapman, D.S., *See* Blackett, R.E., 15:32295
Chapman, L.D., A time-resolved x-ray scattering technique for observation of non-equilibrium phonons, 15:32742 (J;US)
Char, K., *See* Fork, D.K., 15:32631
See Verghese, S., 15:32989
Charalambidis, D., Collisional relaxation of the $6s[3/2]_1{}^0$ and $6s'[1/2]_1{}^0$ m_J levels of xenon using resonantly enhanced multiphoton ionization, 15:33372 (J;US)
Charest, J.A., *See* Lynch, C.S., 15:33037
Charpenay, S., *See* Clapp, P.C., 15:32563
Chase, L.L., *See* Arlinghaus, H.F., 15:32748
See Sokoloff, J.P., 15:32764
Chason, E., *See* Horn, K.M., 15:32584
Chatterjee, A., Interaction of ionizing radiation with matter: Principles and applications, 15:32830 (BA;US)
Track models and radiation chemical yields: Principles and applications, 15:32832 (BA;US)
See Magee, J.L., 15:32831
Chattree, M., *See* Celik, I., 15:32047
Chau, L., Nonresonant three-body decays of charmed mesons, 15:33462 (J;US)
Chaudhuri, J., X-ray diffraction analysis of Au/Ni multilayers, 15:32570 (BA;US)
Chaw, H.H., Application of Fabry-Perot velocimeter to high-speed experiments, 15:32981 (BA;US)
Cheang, F.T., *See* Hu, S.J., 15:33006
Chen Mingjun, *See* Li Zhenping, 15:33599
Chen Shuming, *See* Zheng Hualing, 15:32195
Chen Tianlun, The first order phase transition for six-state Potts model on 2-dimensional random triangle lattice, 15:33489 (R;XA)
Chen, C., Hole excitation spectra in cuprate superconductors: A comparative study of single- and multiple-band strong-coupling theories, 15:32681 (J;US)
Chen, C.T., *See* Ma, Y., 15:32601
Chen, Hanlin, Mechanistic study of chlorine removal from coal by high-temperature leaching, 15:32054 (RA;US)
Chen, J., *See* Jeon, Y., 15:32684
Chen, J.W., *See* Dalichaouch, Y., 15:32761
Chen, T.S., Measurements of heating and energy storage in diode-pumped Nd YAG, 15:33788 (J;US)
Chen, Y.W., *See* Hong, J.W., 15:32744
Chen, Yu-Jiuan, *See* Prono, D.S., 15:32912
Chen, Z.Y., Crossover from singular critical to regular classical thermodynamic behavior of fluids, 15:33396 (J;US)
Cheng, A.Y., *See* James, R.B., 15:32632
Cheng, C.C., Microstructural studies of IAD and PVD Cr coatings by cross section transmission electron microscopy, 15:32734 (BA;US)
Cheng, H., *See* Chau, L., 15:33462
Cheng, J.F., *See* Doggett, N.A., 15:33210
Cheng, S.C., *See* Baw, J.I., 15:32401
Cheng, W.H., *See* Baw, J.I., 15:32401
Cheon, T., *See* Elster, C., 15:33589
Cheong, S., *See* Hundley, M.F., 15:32683
See Migliori, A., 15:32679
See Oseroff, S.B., 15:32677
Cheung, K., *See* Barger, V., 15:33463
Cheverton, R.D., A probabilistic approach to the evaluation of the PTS [pressurized thermal shock] issue, 15:32356 (R;US)
Chia Swee Ping, Radiative decay of the bottom quark and the $WW\gamma$ coupling, 15:33438 (R;XA)
Chiang, T., *See* Mueller, M.A., 15:32599
Chiang, T.T., *See* Wahi, A.K., 15:32757
Chiang, Y.-M., *See* Roshko, A., 15:32901
Chiao, R.Y., *See* Kwiat, P.G., 15:32767
Chiappetta, P., Phenomenological study of the polarized lepto production, 15:33448 (R;FR)
Chidume, C.E., Solution of the Stokes system by boundary integral equations and fixed point iterative schemes, 15:33687 (R;XA)
Chin, B.A., *See* Santanam, L., 15:32239
Ching, W.Y., *See* Xu, Y., 15:32696
Chisholm, M.F., *See* Pennycook, S.J., 15:32698
Chisty, A.F., *See* Lyagushkin, V.P., 15:33627
Chiu, H.K., The measurement of gamma heating in a fusion blanket test assembly, 15:33804 (R;US)
Cho, Gyuseong, Measurements of 1/f noise in A-Si:H pin diodes and thin-film-transistors, 15:32977 (R;US)
Cho, H., *See* Fried, H.M., 15:33525
Cho, W.D., *See* Swisher, J.H., 15:32543
Chong, Y.P., Optical Cherenkov measurements of emittance growth in the Advanced Test Accelerator beam under laser ion-guiding, 15:32946 (BA;US)
See Fawley, W.M., 15:32926
Chopra, O.K., Embrittlement of the Shippingport reactor neutron shield tank, 15:32321 (R;US)
Chou, T.C., Surface energy anisotropy of diffusion-induced Ni_3Al crystals, 15:32567 (BA;US)
Chou, Y.T., *See* Chou, T.C., 15:32567
Chow, P.C., *See* Robertson, J.L., 15:32718
Chrien, R.E., Search for radiative transitions in the hypernucleus $_{\Lambda}{}^{10}B$, 15:33533 (J;US)
Christel, L.A., *See* Miner, G.E., 15:32284
Christensen, B., Model based, sensor directed remediation of underground storage tanks, 15:32858 (R;US)
Chu, C.-Y., *See* Ellingson, W.A., 15:32112
Chumbley, L.S., *See* Kramer, M.J., 15:32650
Ciapala, E., *See* Hansen, S., 15:32963
Ciriza, E., The symplectic structure of submanifolds of Kaehler manifolds of non-positive curvature, 15:33701 (R;XA)
Cizewski, J.A., *See* Becker, J.A., 15:33558
Clapp, P.C., Some thermodynamic propeties of NiAl calculated by molecular dynamics simulations, 15:32563 (BA;US)
Clark, D.P., Genetic approach to microbial coal desulfurization, 15:32056 (RA;US)
Clark, J.C., *See* Prono, D.S., 15:32912
Clark, M.W., *See* Belkacem, A., 15:33635
See Bernstein, E.M., 15:33381
Clarke, K.M., *See* Woodward, J., 15:33215
Clayton, J.C., Internal hydriding in irradiated defected Zircaloy fuel rods, 15:32572 (BA;US)
Clayton, J.L., *See* Bruns, D.A., 15:33124
Clegg, T.B., Sources of spin-polarized beams (invited), 15:32958 (J;US)
Clem, J.R., Phenomenological theory of magnetic structure in the high-temperature superconductors, 15:32662 (BA;US)
See Malozemoff, A.P., 15:32647
Clements, R., *See* Pruneda, C., 15:33030
Clemo, T.M., FRAC-UNIX theory and user's manual, 15:32298 (R;US)
Clodius, W.B., *See* Holland, R.F., 15:33378
Cloutman, L.D., COYOTE: A computer program for 2-D reactive flow simulations, 15:33387 (R;US)
Clupek, M., *See* Piffl, V., 15:33747
See Ripa, M., 15:33746
Cobb, D.D., *See* Holland, R.F., 15:33378

See Robiscoe, R.T., 15:33041
Cocke, C.L., *See* Stockli, M.P., 15:32953
Cockerill, T.M., *See* Bryan, R.P., 15:32774
Coffer, J.L., Infrared spectra of C_2 hydrocarbon ligands coordinated to a triosmium framework: The effect of high pressure as a tool for assignment, 15:32814 (J;US)
Coffey, H.E., Solar-Geophysical Data Number 543, November 1989. Part 2 (comprehensive reports). Data for May 1989 and miscellaneous, 15:33311 (R;US)
Solar-Geophysical Data Number 544, December 1989. Part 1 (prompt reports). Data for November, October 1989, and late data, 15:33312 (R;US)
Solar-Geophysical Data Number 545, January 1990. Part 1 (prompt reports). Data for December, November 1989, and late data, 15:33313 (R;US)
Solar-Geophysical Data Number 545, January 1990. Part 2 (comprehensive reports). Data for July 1989 and miscellaneous, 15:33314 (R;US)
Coffield, F., *See* Prono, D.S., 15:32912
Coffman, D., Study of the doubly radiative decay $J\psi \rightarrow \gamma\gamma\rho^0$, 15:33423 (J;US)
Cole, R.L., Technical and economic evaluation of diesel engine with oxygen enrichment and water injection, 15:32502 (R;US)
Coleman, J., Review of overall safety manual for space nuclear systems: An evaluation of a nuclear safety analysis methodology for plutonium-fueled space nuclear systems, 15:32357 (R;US)
Coleman, J.J., *See* Bryan, R.P., 15:32774
Colinet, E., *See* Griepink, B., 15:32094
Collver, W., *See* Pethica, J.B., 15:32559
Collier, P., *See* Hansen, S., 15:32963
Collings, M.E., *See* Weber, G.F., 15:32310
Collins, G.W., Thermal conductivity of condensed D-T and T_2, 15:32674 (J;US)
Collins, L.A., Atoms in strong, oscillating electric fields: momentum-space solutions of the time-dependent, three-dimensional Schroedinger equation, 15:33357 (J;US)
Collins, P.J., *See* Brumbach, S.B., 15:32326
Collins, T., *See* Jernigan, J.G., 15:32938
Colombo, P., *See* Kalb, P.D., 15:32199
Colten, C.E., Waste minimization in historical perspective, 15:32512 (BA;US)
Comfort, J.R., *See* Ransome, R.D., 15:33532
Compton, R.N., *See* Charalambidis, D., 15:33372
Connell, G.A.N., *See* Fork, D.K., 15:32631
Constantineau, E.J., *See* Ratzel, A.C., 15:33026
Continetti, R.E., *See* Yokoyama, A., 15:32828
Conway, G.D., ECH experiments in SHEILA, 15:33725 (RA;AU)
See Blackwell, B.D., 15:33726
Cook, J., Passive cooling, 15:32483 (B;US)
Cook, J.R., *See* Wilhite, E.L., 15:32248
Cooke, D.W., Magnetic ordering in $(Y_{1-x}Pr_x)Ba_2Cu_3O_7$ as observed by muon-spin relaxation, 15:32693 (J;US)
Surface resistance of $YBa_2Cu_3O_7$ films deposited on $LaGaO_3$ substrates, 15:32900 (BA;US)
See Portis, A.M., 15:32664
Coons, T.A., *See* Bechtold, W.E., 15:33224
See Mewhinney, J.A., 15:33223
Cooper, E.A., High T_c oxide solid state reaction kinetics via complex impedance spectroscopy, 15:32802 (R;US)
Cooper, I., *See* Crisp, V.H.C., 15:32478
Copeland, E.J., Topological defects in extended inflation, 15:33291 (R;US)
Coppersthwaite, D., *See* Griffiths, J.F., 15:32837
Cordell, L.S., *See* McGrail, B.P., 15:33279
Corey, C.M., *See* Burnham, A.K., 15:32529
Corio, L., *See* Peters, N., 15:32317
Corley, J.P., Development and testing of the Hermes-III pulse forming transmission lines, 15:32911 (BA;US)
Cost, J.R., *See* Brown, R.D., 15:32665
Costantino, C.J., NFAP calculation of pressure response of 1/6th scale model containment structure, 15:32394 (RA;US)
Costantino, M.S., *See* Tao, W.C., 15:33031
Costley, A., *See* Gondhalekar, A., 15:33776
Cotench, S.R., *See* Williams, R., 15:33594
Cote, E.A., *See* Senum, G.I., 15:33116
Cotton, T.M., *See* Feng, Qiao, 15:32827
Cottrell, W.D., *See* Miller, C.W., 15:33190
Countryman, P.J., Direct measurement of the branching ratio Γ_n/Γ_f of ^{238}U in inelastic alpha scattering in the giant resonance region, 15:33561 (J;US)
Coustel, N., *See* Ma, J., 15:32768
Covington, J.F. Jr., WIPP/SRL [Waste Isolation Pilot Plant/Savannah River Laboratory] in-situ tests: MIIT [Materials Interface Interactions Tests] program—Glass/metal interfaces of SRS waste glass, 15:32241 (R;US)
Cowart, J.S., Engine knock predictions using a fully-detailed and a reduced chemical kinetic mechanism, 15:32519 (R;US)
Cowherd, C., *See* Axetell, K., 15:32110, 15:32111
Cowles, S., Ozone and acid-precipitation on western coniferous forests, 15:33134 (R;US)
Cowling, E.B., *See* Garner, J.H.B., 15:33085
Crabtree, G.W., *See* Kwok, W.K., 15:32654
See Umezawa, A, 15:32655
Cramer, S.P., *See* George, G.N., 15:32285
Cramond, W.R., *See* Bertucio, R.C., 15:32414, 15:32415
Crawford, E.J., *See* Wilson, R.B. Jr., 15:32050
Crawford, F.S., Elementary examples of adiabatic invariance, 15:33714 (J;US)
Crawford, O.H., *See* Stein, C., 15:33639
Crawford, R.W., *See* Myongsook S. Oh, 15:32188
Crecelius, E.A., Concentrations of metals in Norton Sound seawater samples and human hair samples, 1989, 15:33188 (R;US)
Crisp, V.H.C., Daylighting as a passive solar energy option: an assessment of its potential in non-domestic buildings, 15:32478 (R;GB)
Crittenden, R., *See* Kartik, S., 15:33411
See Sambamurti, A., 15:33418
Crockett, A.B., Soil gas surveying at low-level radioactive waste sites, 15:32215 (R;US)
Croessmann, C.D., *See* Niemer, K.A., 15:33822
Croft, M., *See* Jeon, Y., 15:32684
Cross, W.M., Bubble attachment time measurements for selected rare-earth phosphate minerals in oleate solutions: Extraction preparation and applications, 15:32798 (BA;US)
Croucher, D.W., *See* Durney, J.L., 15:32350
Crow, J.E., *See* Cooke, D.W., 15:32693
Crume, E.C., *See* Isler, R.C., 15:33806
Cruz, M.T.F. da, Decay of ^{132}Cs and nuclear structure of ^{132}Xe, 15:33541 (R;BR)
Cser, L., Monte Carlo modelling for neutron guide losses, 15:32353 (R;HU)
Csernai, L.P., *See* Holme, A.K., 15:33446
Cui, Xiangfeng, Single-sperm typing: Determination of genetic distance between the $^G\gamma$-globulin and parathyroid hormone loci by using the polymerase chain reaction and allele-specific oligomers, 15:33208 (J;US)
Culioli, J.-C., *See* Pin, F.G., 15:32847
Culioli, J.C., *See* Pin, F.G., 15:32846
Cummings, P.T., *See* Blum, L., 15:33397
Cunha, S.F. da, *See* Takeuchi, A.Y., 15:32531
Cupell, L., *See* Hamak, J., 15:32182
Cupps, V.R., *See* Ransome, R.D., 15:33532
Curca-Tivig, F., Modelling of the steam-water-countercurrent flow in the rewetting and flooding phase after loss-of-coolant accidents in pressurized water reactors, 15:32366 (R;DE;In German)
Curlee, T.R., Targets of opportunities for plastics recycling and source reduction, 15:32514 (R;US)
Curry, R.D., Pulse power considerations for the generation of 45 μs, 200 keV electron beams for CO_2 lasers, 15:33827 (BA;US)
Curtis, G.P., *See* Powell, R.M., 15:33170
Curtiss, L.A., *See* Binning, R.C. Jr., 15:33384
Curvers, A., Accuracy of wind measurements and international intercalibration of anemometers, 15:32304 (R;NL;In Dutch)
Cushing, C.E., Hanford Site National Environmental Policy Act (NEPA) characterization: Revision 2, 15:33101 (R;US)
Cussol, D., Theoretical and experimental aspects of the multiple fragmentation reactions in the nucleus-nucleus collisions at intermediate energies, 15:33567 (R;FR;In French)

Cvetic, M., Dynamically generated fermionic masses, 15:33479 (BA;US)

D

D'Amico, K.L., Melting and orientational epitaxy in argon and xenon monolayers on graphite, 15:32776 (J;US)
D'Olivo, J.C., Radiative neutrino decay in a medium, 15:33459 (J;US)
D'Ottavio, T.W., *See* Senum, G.I., 15:33116
Dabrowski, B., Effect of electron and volume change via SB (V) doping on the superconducting behavior of $K_{0.14}Ba_{0.6}Bi_{1-x}Sb_xO_3$, 15:32625 (BA;US)
La_2CuO_{4+gd} and La_2NiO_{4+gd}: Phase separation resulting from excess oxygen defects, 15:32619 (BA;US)
See Kimball, C.W., 15:32626
See Pei, S., 15:32687
Dahl, D.A., SIMION PC/PS2 electrostatic lens design program, 15:33361 (J;US)
See Delmore, J.E., 15:33362
Daido, H., High intensity short pulse generation at ILE Osaka University, 15:32936 (RA;JP)
Dale, J.M., Counterfeit currency detection by principal component analysis of near infrared reflectance data, 15:32791 (BA;US)
Dalichaouch, Y., Effect of transition-metal substitutions on competing electronic transitions in the heavy-electron compound URu_2Si_2, 15:32761 (J;US)
Upper critical field of a $Sm_{1.85}Ce_{0.15}CuO_{4-y}$ single crystal: Interaction between superconductivity and antiferromagnetic order in copper oxides, 15:32670 (J;US)
Dameron, R.A., Analytical correlation and post-test analysis of the Sandia 1:6 scale reinforced concrete containment test, 15:32399 (RA;US)
Dams, R., *See* Griepink, B., 15:32094
Daniel, B.R., *See* Zinn, B.T., 15:32183
Daniels, W.J., Health-hazard evaluation report HETA 89-007-1983, St. Thomas More Hospital, Canyon City, Colorado, 15:33236 (R;US)
Darwish, M.N., *See* Desko, J.C. Jr., 15:32988
Das, A., Wormhole solution in coupled Yang-Mills–axion system, 15:33518 (J;US)
See de Almeida da Silva, M.A., 15:33716
Dasso, C.H., Low-energy reactions with heavy deformed nuclei, 15:33590 (J;US)
Dasu, S., *See* Whitlow, L.W., 15:33433
Datta, B., Development of an expert-system embedding pattern-recognition techniques for pollution-source identification. Report for 30 September 1987-29 November 1989, 15:33171 (R;US)
Daugherty, K.E., *See* Ohlsson, O.O., 15:32513
Davenport, J.W., *See* Watson, R.E., 15:32812
David, F., Electrochemical reduction of actinide ions in aqueous solution and some examples of its application, 15:32833 (R;FR)
Separation of californium from actinides and lanthanides in aqueous solution by electrochemical formation of amalgams, 15:32787 (R;FR)
David, S.A., *See* Goodwin, G.M., 15:32542
Davidson, A., Quark masses and mixing angles from universal see-saw mechanism, 15:33458 (J;US)
Davidson, L.M., *See* Kennedy, K.G., 15:33271
Davis, B.H., *See* Medina, R.J., 15:32078
Davis, G.A., Design considerations for severe accident containment performance, 15:32379 (RA;US)
Davis, J.C., LLNL/UC [Lawrence Livermore National Laboratory]/[University of California] AMS [accelerator mass spectrometry] facility and research program, 15:32941 (R;US)
See Proctor, I.D., 15:32944
See Southon, J.R., 15:32942
See Vogel, J.S., 15:33196
Davis, K.A., Energy conservation through mechanical dehumidification Miramichi Valley High School pool, Newcastle, N.B.: Final report, 15:32515 (R;CA)
Davis, L.T., *See* Hernandez, L. Jr., 15:33863
Daw, M.S., *See* Hoagland, R.G., 15:32587
Dawes, W.R. Jr., *See* Desko, J.C. Jr., 15:32988
Dawson, J., *See* Stevens, A., 15:32966
Dawson, J.M., *See* Su, J.J., 15:32929
Dawson, L.R., *See* Lott, J.A., 15:32758
Dawson, S., *See* Ransome, R.D., 15:33532
Dawson, W.K., *See* Cooke, D.W., 15:32693
Dayras, R.A., *See* Gomez del Campo, J., 15:33537
de Almeida da Silva, M.A, A simple Lagrangian for integrable systems, 15:33716 (J;US)
De Jonghe, L.C., *See* Garg, A.K., 15:32668
de Saussure, G., [International conference on the physics of reactors]: Foreign trip report, April 20, 1990–May 6, 1990, 15:32332 (R;US)
de Vore, L., *See* Burnham, A.K., 15:32529
De Vries, G., *See* Schrama, J.T.A., 15:32291
De, K., *See* Kartik, S., 15:33411
Deacon, D.A.G., *See* Xie, M., 15:32904
Deadrick, F.J., *See* Chong, Y.P., 15:32946
Deak, F., *See* Bastrukov, S.I., 15:33341
Deason, V.A., A convenient system for diffraction moire measurements, 15:32991 (R;US)
Debaets, M., Risks and nuclear insurance, 15:32368 (R;IT)
Debus, R.J., *See* Babcock, G.T., 15:32286
DeBusschere, M.T., *See* Browne, C.L., 15:32450
Decker, D.L., *See* Dabrowski, B., 15:32619
Del-Cas, R., Photo-injector, accelerator chain and wiggler development programs for a high peak power RF-Free electron laser, 15:32921 (R;FR)
DeJongh, F., *See* Coffman, D., 15:33423
Deksnis, E., *See* Dietz, J., 15:33772
See Pick, M.A., 15:33773
del Aguila, F., Hadron-collider limits on new electroweak interactions from the heterotic string, 15:33454 (J;US)
Del Grande, N., Sensor fusion methodology for remote detection of buried land mines, 15:33034 (R;US)
Delepianque, M.A., *See* Becker, J.A., 15:33558
Dellinger, B., *See* Staley, L.J., 15:33086
Delmore, J.E., An autoneutralizing neutral molecular beam gun, 15:33362 (J;US)
See Dahl, D.A., 15:33361
Delzer, D.B., *See* McDaniel, E.W., 15:32250
See Moser, L.V., 15:33060
Demaret, J., Ten-dimensional Lovelock-type space-times, 15:33521 (J;US)
DeMarre, M.E., *See* Schoengold, C.R., 15:33035
Demeter, L., *See* Curry, R.D., 15:33827
Demeure, C.J., *See* Haver, J.F., 15:32432
Demirgian, J.C., Continuous emission monitoring of hazardous waste incinerators using Fourier transform infrared spectroscopy, 15:33110 (BA;US)
Deng Zhongguo, Mass spectrometric measuring of nuclear fuel burnup, 15:32779 (R;CN;In Chinese)
Denison, G.J., *See* Corley, J.P., 15:32911
Dennis, B.S., Hanford Environmental Dose Reconstruction Project: Monthly report, 15:33102 (R;US)
Dennis, K.W., *See* McCallum, R.W., 15:32660
Deonigi, D.E., The technology transfer process: Background for the US national energy strategy, 15:32467 (R;US)
DePristo, A.E., *See* Evans, J.W., 15:33650
Derrick, M., *See* Abachi, S., 15:33420
Des Cloiseaux, J., *See* Jannink, G., 15:33614
deSaussure, G., A new resonance region evaluation of neutron cross sections for ^{235}U, 15:33560 (J;US)
See Spelt, P.F., 15:32843
Desko, J.C. Jr., Radiation hardening of a high voltage IC technology (BCDMOS), 15:32988 (R;US)
Destler, W.W., *See* Antonsen, T.M. Jr., 15:33732, 15:33808, 15:33809
DeVan, J.H., [Oxidation of intermetallics and ceramics]: Foreign trip report, March 23, 1990–April 12, 1990, 15:32553 (R;US)
Devgun, J.S., The environmental compliance process at New York FUSRAP [Formerly Utilized Sites Remedial Action Program] sites, 15:32253 (R;US)
Devine, T.M., Quantitative theory of sensitization, 15:32811 (BA;US)
Dewart, J.M., *See* Stewart, W.F., 15:32265

Dexter, R.N., The Madison Symmetric Torus, 15:33810 (R;US)
Dey, J., Nucleon and isobar properties in a relativistic Hartree-Fock calculation with vector Richardson potential and various radial forms for scalar mass terms, 15:33569 (R;BR)
Observed supersymmetry in baryon and meson spectra with IBFM, the interacting boson fermion model, 15:33441 (R;BR)
Prediction for mesonic spectrum from the discrete quark-gluon states of a finite size bag, 15:33442 (R;BR)
Dey, M., *See* Dey, J., 15:33441, 15:33442, 15:33569
Dezaro, D.A., Electron beam-induced fluorescence as a liquid chromatographic detection technique, 15:32163 (BA;US)
Dhall, S.K., Corona enhanced absorption of SO_2/NO_x, 15:32091 (RA;US)
Dharmaratna, W.G.D., Gluon fusion as a source for massive-quark polarization, 15:33470 (J;US)
Dhere, A., *See* Porter, W.D., 15:32585
Di Marzio, D., *See* Jeon, Y., 15:32684
Di Palo, L., *See* Barsanti, P., 15:32384
Di Vecchia, P., The sewing technique for strings and conformal field theories, 15:33509 (R;DK)
Diamond, D.J., Reactivity accidents: A reassessment of the design-basis events, 15:32402 (RA;US)
Diamond, R.M., *See* Becker, J.A., 15:33558
Dias, S.A., *See* Carneiro, C.E.I., 15:33663
Diaz-Cruz, J.L., *See* Wudka, J., 15:33513
Dib, C.O., Standard-model predictions for *CP* violation in B^0-meson decay, 15:33481 (J;US)
Dickens, M., *See* Beckerman, M., 15:32845
Dickinson, J.T., Fracto-emission from deuterated titanium: Supporting evidence for a fracto-fusion mechanism, 15:33791 (J;US)
Dieckman, S.L., *See* Ellingson, W.A., 15:32112
Dierks, K., Development of a precise hadron calorimeter, 15:32971 (R;DE;In German)
Dietz, J., The JET cryopump: Workshop held at JET on 25/26 September 1989, 15:33772 (RA;GB)
Dietz, R.N., *See* Senum, G.I., 15:33116
Dimenna, R.A., Ranking significant phenomena in physical systems, 15:32358 (R;US)
Dingus, B.L., *See* Haines, T.J., 15:33322
Dion, G.M., *See* Haines, T.J., 15:33322
Diosi, L., On the minimum uncertainty of space-time geodesics, 15:33706 (R;HU)
Disdier, M., *See* Hansen, S., 15:32963
Diver, R.B., *See* Hogan, R.E. Jr., 15:32290
Djurdo, D., *See* Ma, J., 15:32768
Dmowski, W., *See* Toby, B.H., 15:32630
Do Dang, G., *See* Walet, N.R., 15:33585
Dodelson, S., Baryon-symmetric baryogenesis, 15:33512 (J;US)
See Bernstein, J., 15:33318
Dodson, B.W., Atomic-scale modeling of low-energy ion-solid processes, 15:33342 (BA;US)
Metastability in SiGe/Si strained-layer structures: Fundamentals, structure, and devices, 15:32738 (BA;US)
Dodson, G., *See* Reden, K.F. von, 15:33417
Doggett, N.A., The Huntington disease locus is most likely within 325 kilobases of the chromosome 4p telomere, 15:33210 (J;US)
Dolinszky, T., Strong coupling analogue of the Born series, 15:33707 (R;HU)
Doll, P., Neutron-proton scattering, 15:33444 (R;DE)
Dolly, M.C., *See* Desko, J.C. Jr., 15:32988
Donnelly, R., *See* Bockman, R., 15:33212
Donovan, G.L., *See* Wilson, J.M., 15:33829
Dooley, D.F., *See* Abrefah, J., 15:32834
Dorn, R.V. III, PBF/BNCT [Power Burst Facility/Boron Neutron Capture Therapy] Program for Cancer Treatment: Monthly bulletin, Volume 4, No. 3, 15:33222 (R;US)
Dosanjh, S.S., Melt propagation in dry core debris beds, 15:32426 (J;US)
Doss, E.D., Comparative three-dimensional flow analysis of MHD generators and seawater thrusters, 15:32473 (R;US)
Doughty, D.H., *See* Tuttle, B.A., 15:32712
Douglas, G.M., *See* Boyes, J.D., 15:32945
Douglas, L.J., *See* White, C.M., 15:32107
Dow, K.A., *See* Reden, K.F. von, 15:33417
Dowben, P.A., *See* Stauf, G.T., 15:32735
Dowgiallo, E.J., *See* Burke, A.F., 15:32523
Downs, J.L., *See* Link, S.O., 15:32227
Doyle, B.L., *See* Wampler, W.R., 15:32710
Dragt, A.J., Advanced methods for the computation of particle beam transport and the computation of electromagnetic fields and beam-cavity interactions: Annual report, 15:32922 (R;US)
Draper, J.E., *See* Becker, J.A., 15:33558
Draper, P., *See* Sambamurti, A., 15:33418
Dreicer, J.S., Graph Structure Model, 15:33849 (R;US)
Dressendorfer, P.V., *See* Schwank, J.R., 15:32986
Drewery, J.S., *See* Cho, Gyuseong, 15:32977
Drickamer, H.G., *See* Bray, K.L., 15:32592
See Coffer, J.L., 15:32814
Driehuys, B., *See* Kampwirth, R.T., 15:32604
Driese, S.G., *See* Walker, D., 15:33282
Driscoll, D.E., Topological soliton model calculation of the proton-proton parity-violating interaction, 15:33460 (J;US)
Drotning, W., *See* Christensen, B., 15:32858
Drotning, W.D., Sensor-based automated docking of large payloads, 15:32857 (R;US)
Drukier, A.K., Positron Emission Tomography with improved spatial resolution: The ninth months technical report, 15:33213 (R;US)
Dubois, G., *See* Coffman, D., 15:33423
Duchene-Marullaz, P., *See* Flori, J.P., 15:32301
Dudney, C.S., Radon-222, ^{222}Rn progeny, and ^{220}Rn progeny levels in 70 houses, 15:33111 (J;US)
See Gammage, R.B., 15:33118
Duke, C.B., *See* LaFemina, J.P., 15:32808
Dunbar, D.C., *See* Bern, Z., 15:33520
Dungan, T.E., *See* Melloch, M.R., 15:32753
Dunham, R.S., *See* Dameron, R.A., 15:32399
Dunietz, I., *See* Dib, C.O., 15:33481
Dunnam, C.R., *See* Meller, R.E., 15:32962
Dunne, G.V., "Topological" (Chern-Simons) quantum mechanics, 15:33515 (J;US)
Dunwoodie, W., *See* Abe, K., 15:32978
See Aston, D., 15:33410
Duque, R.E., *See* Saltzman, G.C., 15:33214
Durbin, T.E., *See* Barnhart, J.S., 15:32862
Durney, J.L., Replacement of core components in the Advanced Test Reactor, 15:32350 (R;US)
Replacement of the Advanced Test Reactor control room, 15:32351 (R;US)
Dussarte, D., *See* Miannay, D., 15:32533
Dutta, P., *See* Bohanon, T.M., 15:32777
Dwan, S.F., *See* Payne, J., 15:32168, 15:32169, 15:32170
Dworkin, J., *See* James, C., 15:33414
Dyer, R.B., *See* Buelow, S.J., 15:32806
Dytman, S.A., *See* Reden, K.F. von, 15:33417
Dzierba, A., *See* Kartik, S., 15:33411
See Sambamurti, A., 15:33418

E

Earl, J.A., Stochastic simulation of charged particle transport on the massively parallel processor, 15:33302 (RA;US)
Early, E.A., *See* Maple, M.B., 15:32641
See Weir, S.T., 15:32899
Eastman, J.A., Phase control of nanophase materials formed from ultrafine Ti of Pd powders, 15:32623 (BA;US)
Small angle neutron scattering from nanophase titanium as a function of oxidation, 15:32622 (BA;US)
See Epperson, J.E., 15:32621
See Siegel, R.W., 15:32620
Eaton, R.R., *See* Hopkins, P.L., 15:32235
Ebbers, C., *See* Norton, M., 15:32885
Eberle, F., Comparison between calculated and measured eigenfrequencies for spherical steel containment shells, 15:32389 (RA;US)
Echeverria, A., *See* Rizzo, H.F., 15:32569
Eckert, E.M., Transient times of fission in ^{40}Ar+^{232}Th peripheral collisions, 15:33559 (R;DE)

Eckert, H., *See* Tullius, M., 15:32816
Edelstein, M., *See* Leitzke, J., 15:33095
Edeskuty, F.J., *See* Stewart, W.F., 15:32265
Edgerton, E.S., National Dry Deposition Network: Second annual progress report (1988), 15:33092 (R;US)
Edwards, L.K., Validation of "System 21" monobeam transit with computer analysis and large models: Final draft, 15:32491 (R;US)
Edwards, L.L., *See* Harvey, T.F., 15:33108
Edwards, N.W., Proposed acceptance criteria for severe accident evaluations of steel containment vessels, 15:32380 (RA;US)
Efimov, G.V., On a calculation of the ground-state energy in quantum mechanics, 15:33696 (R;XA)
On a phase structure of a three-dimensional ϕ^4 field theory, 15:33501 (R;XA)
Egami, T., *See* Toby, B.H., 15:32630
Eggert, K.G., Surface-water hydrology and sedimentology manual. Final report, 15:32101 (R;US)
Ehgartner, B., Geomechanical analyses in support of the Waste Isolation Pilot Plant (WIPP), 15:32237 (R;US)
Ehret, C.F., *See* Groh, K.R., 15:33260
Ehrlich, S.N., *See* Chapman, L.D., 15:32742
Eibl, J., *See* Bachmann, P., 15:32393
Eigen, G., *See* Coffman, D., 15:33423
Eimerl, D., *See* Norton, M., 15:32885
See Velsko, S.P., 15:32994
Eiro, A.M., *See* Ballot, J.L., 15:33573
Eisenstein, R., *See* Chrien, R.E., 15:33533
Eisert, P., *See* Bachmann, P., 15:32393
Ekchian, L., Real-time bit-wear estimation using surface-vibration signals. Phase 1, 15:33007 (R;US)
El Sawy, A.H., Evaluation of mixed alcohol production processes and catalysts, 15:32273 (R;US)
El-Dessouki, M.S., Surface photovoltage spectroscopy of real n-type GaAs(110) surfaces, 15:33619 (R;XA)
El-Ghor, M.K., Structural characterization of damage in Si(100) produced by MeV Si^+ ion implantation and annealing, 15:32746 (J;US)
See Sjoreen, T.P., 15:32740
El-Gutzirl, S.B., *See* El-Dessouki, M.S., 15:33619
El-Sawy, A., *See* Gray, D., 15:32079
El-Sheikh, S.M., Search for a multiproperty empirical intermolecular potential for $XeSF_6$, 15:32817 (J;US)
Elbaz, E., A new short range gravitational force in the leptonic world, 15:33712 (R;FR)
Ellingson, W.A., Development of nondestructive evaluation methods and prediction of effects of flaws on the fracture behavior of structural ceramics, 15:32112 (R;US)
Radiographic imaging technologies for archaeological ceramics, 15:32629 (BA;US)
Ellison, R.F. Jr., *See* Hernandez, L. Jr., 15:33863
Elster, C., Full-folding optical potentials in elastic proton-nucleus scattering, 15:33589 (J;US)
Elton, R.C., X-ray laser with enhanced x-ray gain through photodepopulation, 15:32905 (P;US)
Emin, D., Reply to "Comment on 'Existence of Wannier-Stark localization' ", 15:33647 (J;US)
Emrich, K.H., *See* Stauf, G.T., 15:32735
England, A.C., *See* Isler, R.C., 15:33806
England, T.R., *See* Brady, M.C., 15:32334
Epperson, J.E., Sintering of nanophase TiO_2 at 550°C, 15:32621 (BA;US)
See Eastman, J.A., 15:32622
Eres, D., Pyrolytic and laser photolytic growth of crystalline and amorphous germanium films digermane (Ge_2H_6), 15:32739 (BA;US)
Erickson, J.M., *See* Bjerstedt, T.W., 15:33281
Erickson, K.L., *See* Skocypec, R.D., 15:33028
Erickson, M.D., *See* Demirgian, J.C., 15:33110
Ericson, M., A consistent treatment of medium effects on hypernuclear pi-mesonic decay, 15:33337 (R;JP)
Essenhigh, R.H., *See* Misra, M.K., 15:32076
Estes, E.D., Development and validation of a test method for formaldehyde emissions. Report for February 1987-April 1989, 15:33081 (R;US)
Eugster, C.C., X-ray detection using the quantum well exciton nonlinearity, 15:33789 (J;US)
Evain, M., *See* Whangbo, M.-H., 15:32803
Evans, J.R., *See* Zucca, J.J., 15:32297
Evans, J.W., Diffusion of noninteracting particles into a semi-infinite lattice, 15:33641 (J;US)
Low-temperature epitaxial growth of thin metal films, 15:33650 (J;US)
Physical modeling of bubble phenomena, electrolyte flow and mass transfer in simulated advanced Hall cells: Final report, 15:32504 (R;US)
Evans, N.A., The effect of charge mixture ratio and particle size on igniter plume heat transfer characteristics, 15:32871 (R;US)
See Skocypec, R.D., 15:33028
Evans, R.D., *See* Link, S.O., 15:32227
Evck, R.A., *See* Cheng, C.C., 15:32734
Ewing, R.C., *See* McGrail, B.P., 15:33279
Exarhos, G.J., *See* McCarthy, J.M., 15:32726
Ezsoel, Gy., *See* Szabados, L., 15:32375
Ezura, E., *See* Kojima, Y., 15:32964

F

Faber, J. Jr., *See* Miller, L.L., 15:32675
See Shaked, H., 15:32688
Fabre de la Ripelle, M., *See* Oehm, W., 15:33563
Fagundes, H., A suggestion on the pair QSO triplets 1130+106 {B,A,C}, {x,y,z}, 15:33294 (R;BR)
Fain, B., *See* Lin, S.H., 15:32801
Fajer, J., *See* Furenlid, L.R., 15:32984
Falco, C.M., *See* Barlingay, C., 15:32692
Falicov, L.M., *See* Freericks, J.K., 15:33642
Fan Shiguo, *See* Zheng Hualing, 15:32195
Fan, Hong Bo, *See* Miller, D.B., 15:32434
Fang, Y.K., *See* Hong, J.W., 15:32744
Fantoni, S., *See* Wang, X.Q., 15:33626
Farnoux, B., *See* Jannink, G., 15:33614
Farrell, M.D., Prospects for alternatives to liquid-petroleum-vehicle fuels. Summary of the annual GRI (Gas Research Institute) energy seminar (10th) for the GRI board of directors and advisory council. Held in Vail, Colorado on August 7-9, 1989. Topical report, 15:32526 (R;US)
Fathy, D., *See* Ravindra, N.M., 15:32737
Faucett, D.L., *See* Harper-Slaboszewicz, V.J., 15:32918
Fawley, W.M., Time-dependent degradation of an ion-focused ATA beam, 15:32926 (BA;US)
Fayn, B., *See* Morris, D.E., 15:32686
Fearon, E.M., *See* Collins, G.W., 15:32674
Fecht, H.J., *See* Hellstern, E., 15:32566
Fedele, R., *See* Su, J.J., 15:32929
Fedro, A.J., *See* Chen, C., 15:32681
Fedyanin, V.K., *See* Taranko, R., 15:33625
Feeley, T.J. III, *See* Hoffman, L., 15:32313
Feenstra, R., Comparison between $LaGaO_3$, $LaAlO_3$,$KTaO_3$ and $SrTiO_3$ substrates for the epitaxial growth of $YBa_2Cu_3O_{7-x}$ thin films by a BaF_2 process, 15:32653 (BA;US)
Felder, E., The low-temperature phase diagram of $U_{2-x}Th_xBe_{13}$, 15:32581 (BA;US)
Feldman, D.L., International decision making and global climate change: Lessons of prior resource management efforts for consensus building, 15:33053 (R;US)
Fellows, P.M., *See* Williams, R.R., 15:32117
Felton, J.S., *See* Vogel, J.S., 15:33196
Fendler, J.H., *See* Zhao, Xiao Kang, 15:32763
Feng Weiguo, Effect of retardation on the reflectance properties of the metallic Fibonacci quasi-superlattice, 15:33623 (R;XA)
New real space correlated-basis-functions approach for the electron correlations of the semiconductor inversion layer, 15:33622 (R;XA)
Feng, Qiao, Surface-enhanced resonance Raman scattering from methylviologen at a silver electrode: Evidence for two distinct adsorption interactions, 15:32827 (J;US)
Fenske, G.R., *See* Cheng, C.C., 15:32734

Fergerson, R.W., *See* Ransome, R.D., 15:33532
Ferguson, S.M., *See* Belkacem, A., 15:33635
Fernandes, M., *See* Xia, W., 15:32760
Fernandez, J.C., *See* Barnes, D.C., 15:33820
Fernandez-Niello, J., *See* Dasso, C.H., 15:33590
Fernando, G.W., *See* Watson, R.E., 15:32812
Ferreira, L.A., Symplectic bosons, Fermi fields and super Jordan algebras, 15:33702 (R;BR)
Ferreira, P.L., *See* Palladino, B.E., 15:33440
Fesen, R.A., Optical detection of the remnant of SN 1980K in NGC 6946, 15:33319 (J;US)
Fett, T., Subcritical crack growth in hot-isostatically postcompacted high-grade alumina, 15:32614 (R;CH)
Fidler, A.T., *See* Bicknell, R., 15:33074
Fiedeldey, H., *See* Oehm, W., 15:33563
Field, G.B., *See* Carroll, S.M., 15:33524
Fiksel, G., Experimental simulation of a gaseous plasma collector, 15:33834 (J;US)
Fineschi, F., *See* Carcassi, M., 15:32381
Fingleton, D. J., Assessing inhalation risks from the land treatment of petroleum refining wastes, 15:32151 (B;US)
Fingleton, D.J., *See* Haroun, L.A., 15:32202
Fink, T., *See* Ravindra, N.M., 15:32737
Finkenthal, M., *See* Huang, L.K., 15:33799
Finn, J.M., *See* Lau, Yuntung, 15:33321
Fischer, A.K., Desorption of H_2O and H_2 from steel and $LiAlO_2$ by temperature programmed desorption, 15:33805 (R;US)
Fischer, C.L., *See* Whittier, J., 15:33218
Fischer, G.E., SLAC [Stanford Linear Accelerator Center] site geology, ground motion and some effects of the October 17, 1989 earthquake, 15:33277 (R;US)
Fischer, J.E., *See* Ma, J., 15:32768
Fischer, R., Production of a short hydrogen gas pulse by laser-induced desorption from titanium hydride for investigation of transport processes in fusion plasmas, 15:33761 (R;DE;In German)
Fischer, S.K., Thermodynamic calculations for mixtures of environmentally safe refrigerants using the Lee-Kesler-Ploecker equation of state, 15:32701 (R;US)
Fish, J.D., *See* Hogan, R.E. Jr., 15:32290
Fisher, J.L., A magnetographic technique for inspection of containment welds through coatings: Final report, 15:32337 (R;US)
Fisher, R.., *See* Phillips, N.E., 15:32613
Fisk, Z, *See* Takigawa, M, 15:32658
Fisk, Z., *See* Felder, E., 15:32581
See Hundley, M.F., 15:32683
See Li, W., 15:32685
See Lynn, J.W., 15:32680
See Migliori, A., 15:32679
See Oseroff, S.B., 15:32677
See Severing, A., 15:32591
Fitzpatrick, R., *See* Diamond, D.J., 15:32402
Fleetwood, D.M., Evidence that similar point defects cause 1/*f* noise and radiation-induced-hole trapping in metal-oxide-semiconductor transistors, 15:32749 (J;US)
Predicting switched-bias response from steady-state irradiations, 15:33042 (R;US)
See Meisenheimer, T.L., 15:32987
See Shaneyfelt, M.R., 15:32882
See Winokur, P.S., 15:32881
Fleming, B.A., Production of jet fuels from coal derived liquids: Volume 6, Preliminary analysis of upgrading alternatives for the Great Plains liquid by-product streams: Interim report, March 1987–February 1988, 15:32058 (R;US)
Fleury, N., *See* Rausch Traubenberg, M. de, 15:33666
Flickinger, A., Laser-guidance systems, security classification. Instruction, 15:33016 (R;US)
Flippen, R.B., *See* Leary, K.J., 15:32666
Floch, H.G., Optical coatings processed by CO2 laser sintering, 15:32532 (R;FR)
Florl, J.P., Wind potential energy determination at Cammazes site, 15:32301 (R;FR;In French)
Florian, R.J., *See* Shea, M.F., 15:32915
Flynn, G.J., Trace element abundance determinations by Synchrotron X Ray Fluorescence (SXRF) on returned comet nucleus mineral grains, 15:33304 (RA;US)
Fogdall, S.P., *See* Bonzon, C.J., 15:32249
Folles, S.M., *See* Hoagland, R.G., 15:32587
Folkerts, T.J., Preparation and characterization of single phase $Ba_{1-x}K_xBiO_3$, 15:32651 (BA;US)
Follansbee, P.S., An analysis of the low temperature, low and high strain-rate deformation of Ti-6Al-4V, 15:32589 (J;US)
Follstaedt, D.M., Tribology of amorphous alloys formed with ion beams, 15:32573 (BA;US)
See Myers, S.M., 15:33344
Fong, C.Y., *See* Yang, L.H., 15:32741
Ford, W.T., Interactive beam tuning simulator for the SLC Final Focus, 15:32927 (BA;US)
Fork, D.K., YBCO films on YSZ and Al_2O_3 by pulsed laser deposition, 15:32631 (BA;US)
Fornoff, L.L., *See* Fleming, B.A., 15:32058
Forster, C.B., *See* Blackett, R.E., 15:32295
Fortson, N.H., *See* Lawler, J.S., 15:32429
Fortune, H.T., *See* Mordechai, S., 15:33535
Fossan, D.B., *See* Piel, W.F. Jr., 15:33548
Foster, K.G., *See* Myongsook S. Oh, 15:32188
Fothergill, S., *See* Barrett, M., 15:32329
Fouresf, B., *See* David, F., 15:32787
Fowler, W.E., *See* Harper-Slaboszewicz, V.J., 15:32918
Fox, J., *See* Furlong, M., 15:32059, 15:32060
Fox, J.D., *See* Fleming, B.A., 15:32058
See Furlong, M.W., 15:32061, 15:32062, 15:32063, 15:32064, 15:32065
Fox, W.A. III, *See* Davis, G.A., 15:32379
Fragola, J., *See* Wreathall, J., 15:32420, 15:32421
Franco, M.A.R., Determination of calibration constants for perturbing objects of cavity resonators, 15:32879 (R;BR;In Portuguese)
Frank, A.M., High-Speed Microphotographic Laboratory, 15:33013 (BA;US)
Frank, J., *See* Pferdehirt, W., 15:33165
Franke, A., Progeny test of Norway Spruce stands in the Black Forest (areas of origin 840 08 and 840 09) aiming at: 1. Improvement of immission tolerance. 2. Conservation of genetic resources of damaged stands in high altitudes ('Gene Bank'), 15:33233 (R;DE;In German)
Franklin, G., *See* Chrien, R.E., 15:33533
Franklin, T.L., *See* Boyes, J.D., 15:32945
Franz, J.A., *See* Linehan, J.C., 15:32087
Frederick, E., *See* Squillante, M.R., 15:32260
Freeman, D.H., Derivative spectrophotometry of metalloporphyrins from shale, 15:32187 (BA;US)
Freericks, J.K., Two-state one-dimensional spinless Fermi gas, 15:33642 (J;US)
Freeze, G.A., *See* Belanger, D.W., 15:33269
Freiser, H., Solvent extraction equilibria of tervalent lanthanides: A systematic investigation of selectivity of chelate extraction: Extraction preparation and applications, 15:32797 (BA;US)
Friberg, S.R., *See* Sakai, Y., 15:32996
Fridzon, M.B., Method of fabricating an oxide-aluminum humidity sensor, 15:33002 (R;US)
Fried, H.M., Nonperturbative QED and loop bremsstrahlung of neutral lepton pairs in heavy-ion collisions, 15:33525 (J;US)
Friedsam, H., *See* Bell, B., 15:32910
Friese, J., *See* Beier, G., 15:33540
Friesner, R.A., *See* Belhadj, M., 15:33202
Froger, C., *See* Last, J.R., 15:33771
Frogget, B.C., *See* Holland, R.F., 15:33378
Fruneau, M., *See* Belmont, J.L., 15:32908
Frydrych, W.S., *See* McCarthy, J.M., 15:32726
Frye, G.C., *See* Hietala, S.L., 15:32615
See Martin, S.J., 15:33008
Fu, C.L., Stacking fault energies, crystal elasticity and their relation to the mechanical properties of $L1_2$-ordered alloys, 15:32561 (BA;US)
Fuertjes, A., Behaviour of the ZEUS uranium-scintillator calorimeter for low-energetic particles with energies of 0.2 - 10.0 GeV, 15:32972 (R;DE;In German)

Fuhrmann, C., *See* Franco, M.A.R., 15:32879
Fujieda, I., *See* Cho, Gyuseong, 15:32977
Fujita, E.K., *See* Wade, D.C., 15:32427
Fujita, S., Anthropogenic sulfur dioxide emission in Far East Asia, 15:32098 (R;JP;In Japanese)
Fujiwara, I., Study on (γ, π^+), (γ,π^-xn) rections, photo-spallation and photo-fragmentation reaction, 15:33447 (RA;JP;In Japanese)
Fujiwara, T., *See* Gunnarsson, O., 15:32694
Fujiwara, Y., Multiconfiguration resonating-group theory of ^{6}Li, 15:33579 (J;US)
Fukumoto, S., *See* Alton, G.D., 15:32957
Fullerton, E., *See* Robertson, W.M., 15:32598
Fulton, J.L., *See* Tingey, J.M., 15:32815
Fumizawa, Motoo, *See* Yamashita, Kiyonobu, 15:32323
Fuoss, P.H., Application of x-ray scattering to the in situ study of organometallic vapor phase epitaxy, 15:32721 (BA;US)
Furenlid, L.R., A cell for extended x-ray absorption fine structure studies of oxygen sensitive products of redox reactions, 15:32984 (J;US)
Furlong, M., Production of jet fuels from coal derived liquids: Volume 9, Results of bench-scale testing and pilot plant testing: Interim report, February 1988–March 1989, 15:32059 (R;US)
Production of jet fuels from coal-derived liquids: Volume 12, Preliminary process design and cost estimate and production run recommendation: Final report, March 1989–December 1989, 15:32060 (R;US)
Furlong, M.W., Production of jet fuel from coal-derived liquids: Report No. 16: Quarterly technical progress report, second quarter FY 1988, January 1, 1988–March 31, 1988, 15:32061 (R;US)
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 17, April 1–June 30, 1988, 15:32062 (R;US)
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 23, July 1–September 30, 1988, 15:32063 (R;US)
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 25, October 1–December 31, 1988, 15:32064 (R;US)
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 29, January 1–March 31, 1989, 15:32065 (R;US)
See Fleming, B.A., 15:32058
Furtado, W.W., *See* Isotani, S., 15:33335
Furtner, R., Defense Nuclear Agency (DNA). Directive, 15:33015 (R;US)
Strategic Defense Initiative Organization. Directive, 15:32527 (R;US)
Furuya, T., *See* Kojima, Y., 15:32964
Fussmann, G., An optical scanning system for spectroscopic impurity flux investigations inside the ASDEX tokamak, 15:33760 (R;DE)
Sputtering flux measurements in the ASDEX divertor, 15:33818 (R;DE)

G

Gaines, J.R., *See* Collins, G.W., 15:32674
Gaias, D., *See* Cui, Xiangfeng, 15:33208
Gale, L.G., *See* Ayers, A.L. Jr., 15:32216
Galetti, D., *See* Aldrovandi, R., 15:33704
See Mizrahi, S.S., 15:33703
Gallagher, J.R., *See* Turner, C.D., 15:33189
Galloway, M.D., *See* Feenstra, R., 15:32653
Galvin, J.E., *See* Brown, I.G., 15:33353
Galyean, W.J., *See* Gertman, D.I., 15:32416
Gamble, J.F., *See* Piacitelli, G.M., 15:33073
Gammage, R.B., Performance experience with radon mitigation systems, 15:32480 (R;US)
Summertime elevation of radon in southern Appalachian homes, 15:33049 (R;US)
Transport studies of radon in limestone underlying houses, 15:33118 (R;US)
Unusual formaldehyde-induced hypersensitivity in two schoolgirls, 15:33257 (R;US)
See Wilson, D.L., 15:32481
Ganguin, J., *See* Keusen, H.R., 15:33267
Gao Shuqin, *See* Deng Zhongguo, 15:32779
Gao, B., Variational methods for high-order multiphoton processes, 15:33360 (J;US)
Gao, Y., *See* Bai, G.R., 15:32607
See Chang, H.L.M., 15:32606
Garbincius, P., *See* Roe, N.A., 15:33412
Garcia, E., *See* Dickinson, J.T., 15:33791
Garcia-Vazquez, V., *See* Barlingay, C., 15:32692
Gardner, R.H., *See* Turner, M.G., 15:33051
Garg, A.K., Microencapsulation of silicon nitride particles with yttria and yttria-alumina precursors, 15:32668 (J;US)
Garibaldi, J.L., *See* Proctor, I.D., 15:32944
Garland, C., *See* Hellstern, E., 15:32566
Garner, J.H.B., Evaluation of the role of ozone, acid deposition, and other airborne pollutants in the forests of eastern North America. Forest Service general technical report, 15:33085 (R;US)
Garost, A.I., *See* Svidunovich, N.A., 15:33628
Garralt, M., *See* Hogan, R.E. Jr., 15:32290
Garrett, S.L., *See* Larraza, A., 15:33395
Garribba, M., *See* Noll, P., 15:33770
Getoff, G., Fermions at high temperature, 15:33514 (J;US)
Gavin, J.E., *See* Kukla, G.J., 15:33054
Gay, D.W., Measurement of the deposition and fate of sulfur-dioxide-35 in a pine plantation, 15:33113 (J;US)
Gazzaly, M., *See* Moshi, M.G., 15:33557
Geacintov, N.E., *See* Pope, M., 15:32813
Gear, C.W., *See* Xuhai, Xu, 15:33844
Gearhart, R., *See* Rolfe, J., 15:32947
Geary, J.L., Computer simulation of Alfven wave heating, 15:33795 (J;US)
Gebalie, T.H., *See* Fork, D.K., 15:32631
Gebhard, R.L., Proximity of Delaware sanitary landfills to wetlands and deepwater habitats: Data on individual landfills. Part B, 15:33151 (R;US)
See Herndon, R.C., 15:33150
Gee, G.W., *See* Campbell, M.D., 15:32228
Gelfand, N., The SHOT SUMMARY system for the Tevatron collider, 15:32914 (BA;US)
Gemmell, J.M., Water levels in periodically measured wells in the Yucca Mountain Area, Nevada, 1988, 15:32240 (R;US)
Genis, A.P., *See* Kimball, C.W., 15:32626
Gentilion, C.D., *See* Gertman, D.I., 15:32416
Geohegan, D.B., *See* Eres, D., 15:32739
George, E.P., Identification of cleavage planes in the Al_3Ti-base alloy by electron channeling in the SEM, 15:32577 (BA;US)
See Horton, J.A., 15:32560
George, G.N., The manganese site of the photosynthetic water-splitting enzyme, 15:32285 (J;US)
George, M.L., Practical ice thermal storage applications, 15:32490 (B;US)
Gertman, D.I., Nuclear Computerized Library for Assessing Reactor Reliability (NUCLARR): Summary description: Volume 1, Revision 1, 15:32416 (R;US)
Gessert, T.A., Moessbauer spectroscopy study of the kinetics of photoreduction of Fe^{3+} on CdS semiconductor powders, 15:32762 (J;US)
Ghamaty, S., *See* Maple, M.B., 15:32641
Ghirardi, G.C., Old and new ideas in the theory of quantum measurement, 15:33683 (R;XA)
Ghosh, A., The chevron-notched bend bar technique for fracture resistance measurements of ceramics, 15:32652 (BA;US)
Giambiagi, J.J., *See* Bollini, C.G., 15:33430, 15:33474
Giambiagi, M., Definition of a multicentral bond index, 15:33326 (R;BR)
Giambiagi, M.S. de, *See* Giambiagi, M., 15:33326
Giese, R.F., Magnetic heat pumps, 15:32499 (R;US)
Gilbert, B.G., *See* Gertman, D.I., 15:32416
Gilbertsen, R.H., *See* Miller, C.T., 15:33169
Gilfoyle, G.P., *See* Boger, J., 15:33538
Gill, R.L., *See* Buescher, M., 15:33545
See Mach, H., 15:33543, 15:33544, 15:33546
Gilliam, T.M., *See* Spence, R.D., 15:32245
Gilligan, J.G., *See* Niemer, K.A., 15:33822

Gilman, F.J., *See* Dib, C.O., 15:33481
Gilman, J.J., Novel method for constructing tetrahedral frames, 15:32731 (BA;US)
Gilmore, T.J., Evaluations of the effects of the Columbia River on the unconfined aquifer beneath the 1301-N Liquid Waste Disposal Facility, 15:32232 (R;US)
Gilmore, W.E., *See* Gertman, D.I., 15:32416
Ginely, D.S., *See* Ansaldo, E.J., 15:32633
Ginley, D.S., *See* Halloran, J.W., 15:32616
Girardi, G., *See* Chiappetta, P., 15:33448
Gladney, E.S., Quality control and the use of reference materials in an environmental laboratory, 15:33011 (BA;US)
Glaess, F., *See* Schneefuss, J., 15:32225
Glandt, E.D., *See* Kofke, D.A., 15:32819
Glass, M.W., *See* Skocypec, R.D., 15:33028
Gleason, K., *See* Burnham, A.K., 15:32529
Gledhill, B.L., *See* Vogel, J.S., 15:33196
Glenn, A.W., *See* Ward, T.E., 15:32077
Glenn, L.A., Modeling jet penetration in glass, 15:33033 (R;US)
Gleslus, F.L., *See* Williams, J.A., 15:32197
Glish, G.L., [Applied mass spectrometry in the health sciences]: Foreign trip report, April 15–April 21, 1990, 15:32788 (R;US)
See Asano, K.G., 15:33216
See Grant, B.C., 15:33023
See McLuckey, S.A., 15:32795
See Van Berkel, G.J., 15:32165
Gloeggler, W., *See* Pahl, A., 15:33274
Glovka, D.A., Lost circulation technology development projects, 15:32299 (R;US)
Glowienka, J.C., *See* Isler, R.C., 15:33806
Glowka, D.A., *See* Loeppke, G.E., 15:32300
Gluckstern, R.L., *See* Dragt, A.J., 15:32922
Glyde, H.R., *See* Hakim, T.M., 15:32759
Gobrial, F.Z., *See* El-Dessouki, M.S., 15:33619
Godon, N., Effect of environmental materials on R7T7 nuclear waste glass alteration. Clay effect, 15:32201 (R;FR;In French)
Godyak, V.A., Smooth plasma-sheath transition in a hydrodynamic model–, 15:33830 (J;US)
Goeller, B., *See* Eberle, F., 15:32389
Gogokhia, V.Sh., Gauge-invariant, nonperturbative approach to the infrared-finite bound-state problem in QCD, 15:33504 (R;HU)
Goichert, B., *See* Landsberger, S., 15:33145
Goichert, N.W., Surveillance of Site A and Plot M report for 1989, 15:33137 (R;US)
Golden, D.W., *See* Kuan, P., 15:32319
Goldman, I.D., *See* Cruz, M.T.F. da, 15:33541
Goldman, T., Gravity and antimatter, 15:33713 (J;US)
Goldstein, G.R., *See* Dharmaratna, W.G.D., 15:33470
Goldstein, H.F., Planform selection in rotating convection, 15:33392 (J;US)
Goldstein, W.H., *See* Liedahl, D.A., 15:33325
Gomes, J.F., *See* Ferreira, L.A., 15:33702
Gomez del Campo, J., Measurements of time delays for projectile-like fragments in the reaction $^{40}Ar+Ge$ at 44 MeV/nucleon, 15:33537 (J;US)
See Beene, J.R., 15:33554
Gommlich, G., *See* Schneefuss, J., 15:32225
Gondhalekar, A., Diagnostic measurements of the pumped divertor plasma: Workshop held at JET on 25/26 September 1989, 15:33776 (RA;GB)
Gong, C., *See* Hong, J.W., 15:32744
Goodman, A.L., *See* Akovali, Y.A., 15:33551
Goodrich, R.W., *See* Senum, G.I., 15:33116
Goodwin, C.A., *See* Desko, J.C. Jr., 15:32988
Goodwin, G.M., Weldability of nickel aluminides, 15:32542 (R;US)
See Lundin, C.D., 15:32045
Goodwin, R.W., *See* Shea, M.F., 15:32915
Goodzelt, C., Summary of construction details and test performance of recent series of 1.8 meter SSC dipoles at BNL, 15:32930 (R;US)
Gopalakrishnan, J., *See* Toby, B.H., 15:32630
Gopalsami, N., *See* Ellingson, W.A., 15:32112
Goradia, T.M., *See* Cui, Xiangfeng, 15:33208
Gordon, A.M.P.L., Evaluation of the effective equivalent dose in the general public due to the discharge of uranium in groundwater, 15:33600 (R;BR;In Portuguese)
Gordon, R.J., The origin of small and large molecule behavior in the vibrational relaxation of highly excited molecules, 15:32821 (J;US)
Goretta, K.C., Practical superconductor development for electrical power applications: Annual report for FY 1989, 15:32878 (R;US)
See Wagener, T.J., 15:32689
Gorman, J.A., Proceedings: Primary water stress corrosion cracking: 1989 EPRI remedial measures workshop, 15:32336 (R;US)
Gormezano, C., Modification to the lower hybrid system: Workshop held at JET on 25/26 September 1989, 15:33775 (RA;GB)
Gosdin, C.H., *See* Vineyard, M.F., 15:33534
Gosselink, J.G., *See* Lee, L.C., 15:33175
Gottlieb, S., QCD thermodynamics with eight time slices, 15:33516 (J;US)
Gourley, P.L., *See* Reno, J.L., 15:32754
Gowens, J.W., *See* Von Schweber, E., 15:33857
Grace, J.M., *See* Kampwirth, R.T., 15:32604
Grace, R., *See* Chrien, R.E., 15:33533
Graczyk, L.J., *See* Neill, P.H., 15:32088
Graettinger, T.M., *See* Ameen, M.S., 15:32635
Graham, A.L., *See* Abbott, J.R., 15:33632
Graham, G., Excitation of pulsed flashlamps with a linear response high power amplifier, 15:32891 (BA;US)
Graham, J.A., Review, discussion, and summary: Toxicology, 15:33248 (R;US)
Graham, W.G., *See* Bernstein, E.M., 15:33381
Granatstein, V.L., *See* Antonsen, T.M. Jr., 15:33732, 15:33808, 15:33809
Grange, P., *See* Mathiot, J.F., 15:33443
Grant, B.C., Explosives detection using an atmospheric sampling glow discharge ionization source with an ion trap mass spectrometer, 15:33023 (BA;US)
Grasseschi, G.L., *See* Brumbach, S.B., 15:32326
Gray, D., A techno-economic evaluation of copressing technologies, 15:32079 (BA;US)
Gray, E.R., *See* Cooke, D.W., 15:32900
Gray, G.T., *See* Follansbee, P.S., 15:32589
Gray, K.E., *See* Kampwirth, R.T., 15:32604
See Woo, K.C., 15:32661
Grdina, D.J., *See* Nagy, B., 15:33221
Green, A., *See* Ransome, R.D., 15:33532
Green, M.D., *See* Davis, G.A., 15:32379
Green, R.M., *See* Wilk, R.D., 15:32520
Greenberg, R.M., *See* Blattner, M.M., 15:33388
Greene, A.E., *See* Woodside, S.L., 15:32548
Greene, E.F., *See* Bu, Y., 15:33646
Greene, S., *See* Mordechai, S., 15:33535
Greene, S.E., *See* Bruns, D.A., 15:33124
Greenway, W.G., *See* Rutkowski, H.L., 15:33833
Gregoire, C., *See* Sebille, F., 15:33577
Gregory, D.I., Determination of drainage density for surface-mine reclamation in the western US. Final report, 15:32099 (R;US)
Gregory, W.S., Node-based network analysis and its application to mine ventilation, 15:32876 (BA;US)
See Nichols, B.D., 15:32877
Grest, G.S., *See* Kwon, I., 15:32773
Griepink, B., The certification of the surface density (kg/m_2) of BCR CRM 038 ('fly ash from pulverised coal') comprised in methyl cellulose films simulating dust charged filters. BCR 128, 15:32094 (R;XE)
Griffin, D.C., The theory of electron-ion collisions: The role of doubly excited states, 15:33328 (R;US)
See Pindzola, M.S., 15:33370
Griffin, P.J., An examination of the 1-MeV equivalent silicon damage methodology, 15:32557 (R;US)
Griffioen, K.A., *See* Countryman, P.J., 15:33561
Griffiths, J.F., Auto-ignition temperatures of binary mixtures of alkanes in a closed vessel: Comparisons between experimental measurements and numerical predictions, 15:32837 (R;US)
Griggs, D.P., *See* Hanson, R.G., 15:32359
Grigoriev, D.Yu., Electroweak BAU generation on the lattice: Real time vs. Euclidean approach, 15:33507 (R;DK)

Grimaldi, G., *See* Barsanti, P., 15:32384
Grimsditch, M., *See* Robertson, W.M., 15:32598
Groeneweg, M.A., *See* Hakim, N.S., 15:32522
Groh, K.R., Chronobiological effects of electric fields: The question of cancer, 15:33260 (BA;US)
Groh, M.R., *See* Gertman, D.I., 15:32416
Gronsky, R., *See* Hetherington, C.J.D., 15:33012
See Nguyen, T.D., 15:32579
Grose, T., *See* Milton, K.A., 15:33522
Gross, M.A., *See* Rutkowski, H.L., 15:33833
Gross, V.E., *See* Patterson, S.R., 15:33038
Gruen, D.M., *See* Arlinghaus, H.F., 15:32748
Grumbine, R.W.. Identification of oscillations in Ross Sea current data, 15:33280 (J;US)
Gruner, P., *See* Bachmann, P., 15:32393
Grypeos, M.E., The relative probability for the recoilless Λ-production in nuclei in the plane wave impulse approximation, 15:33568 (R;XA)
Gryzinski, M., Investigation of ion implosion on the thermonuclear facility SOWA-400, 15:33817 (RA;CS;In Russian)
Gschneidner, K.A. Jr., *See* Beaudry, B.J., 15:32799
Guerin, M.R., *See* Wise, M.B., 15:32782, 15:33050
Guerreiro, J.N.C., Applications of mixed Petrov-Galerkin finite element methods to transient and steady state creep analysis, 15:33709 (R;BR)
See Loula, A.F.D., 15:33710
Guffey, F.D., *See* Smith, E.B., 15:32048
Guglhoer, P., *See* Schuler, A.K., 15:33046
Guidotti, R., *See* Redey, L., 15:32441
Guidotti, R.A., Self-discharge study of Li-alloy/FeS_2 thermal cells, 15:32440 (R;US)
Gunnarsson, O., Polarized resonance photoemission for Nd_2CuO_4, 15:32694 (J;US)
Gunther, W., The use of NPAR [Nuclear Plant Aging Research] results in plant inspection activities, 15:32413 (RA;US)
Guo Hanying, Beltrami algebra and symmetry of Beltrami equation on Riemann surfaces, 15:33681 (R;XA)
See Chang Zhe, 15:33498
Guo, J., *See* Chang, H.L.M., 15:32606
Gutknecht, W.F., *See* Estes, E.D., 15:33081
Gutman, D., *See* Wagner, A.F., 15:32840
Guziel, K.A., Technology choice in a least-cost expansion analysis framework: The impact of gas prices, planning horizon, and system characteristics, 15:32318 (R;US)

H

Haasbeek, J.F., *See* Newell, C.J., 15:33149
Haber, S.B., *See* Metlay, D.S., 15:32403
Habiger, K.W., *See* Stein, C., 15:33639
Hacker, U., *See* Maier, R., 15:32948
Hageman, E.W., Local structure evaluation in solid amorphous mixtures by double cross polarization C13 nuclear magnetic resonance spectrometry, 15:32086 (BA;US)
Hagelstein, P.L., *See* Eugster, C.C., 15:33789
Hagiwara, K., Weak-boson production by charm quarks, 15:33421 (J;US)
Hagrman, D.L., *See* Hobbins, R.R., 15:32345
Hahn, H., Microstructure of nonocrystalline ceramics, 15:32624 (BA;US)
See Eastman, J.A., 15:32622
Hahn, P.A., *See* Violet, C.E., 15:32663
Hahn, Y., *See* Janjusevic, M., 15:33351
Haines, T.J., Limit on possible energy-dependent velocities for massless particles, 15:33322 (J;US)
Hakim, N.S., Ceramic port shields cast in an iron engine head, 15:32522 (J;US)
Hakim, T.M., Phonons in solid argon monolayers, 15:32759 (J;US)
Halbert, M.L., *See* Beene, J.R., 15:33554
Halbleib, J.A., *See* Beutler, D.E., 15:32937
Hall, J.A., *See* Levins, W.P., 15:32484
Haller, E.E., *See* Bliss, D.E., 15:32755
See Wang, N., 15:32595
Hallewell, G., *See* Abe, K., 15:32978
Halloran, J.W., Rapid thermal processing of high temperature superconducting fiber, 15:32616 (R;US)
Halverson, W., *See* Pu, Y.K., 15:32954
Halzen, F., Cosmology with 100-TeV γ-ray telescopes, 15:33317 (J;US)
See Hagiwara, K., 15:33421
Hamagima, Y., *See* Fujiwara, I., 15:33447
Hamak, J., Analyses of natural gases, 1917-1989. Data file, 15:32182 (R;US)
Hamberger, S.M., Configurational effects on plasma confinement in SHEILA, 15:33724 (RA;AU)
See Blackwell, B.D., 15:33729
Hamilton, M.W., *See* Arnett, K., 15:33380
Hamilton, W.D., *See* Veskovic, M., 15:33595
Hammel, P.C., *See* Takigawa, M, 15:32658
Hammersley, R.J., *See* Sharon, A., 15:32361
Hammond, T., *See* Cerny, B.A., 15:33858
Hammons, B.E., *See* Carson, R.F., 15:33043
Handler, R., *See* James, C., 15:33414
Hanna, W.T., *See* Gammage, R.B., 15:33257
Hannaford, R., *See* Scanlan, R.M., 15:32897
Hannon, R.H., *See* Dabrowski, B., 15:32625
See Kimball, C.W., 15:32626
Hansen, S., Digital control of the LEP RF system, 15:32963 (BA;US)
Hanson, R.G., Development of a PIRT (phenomena identification and ranking table) for a postulated double-ended guillotine break in a production reactor, 15:32359 (R;US)
Hara, F.T., SST [single-shell tank] sample characterization analysis of archive samples 102-C, 105-C, and 106-C, 15:32230 (R;US)
Hara, K., *See* Kojima, Y., 15:32964
Harbour, P.J., Experimental evidence from present X-point operation in JET: Workshop held at JET on 25/26 September 1989, 15:33767 (RA;GB)
See Watkins, M.L., 15:33766
Hardarson, G., *See* Zapata, F., 15:33839
Hardesty, D.R., Coal Combustion Science quarterly progress report, January–March 1990, 15:32118 (R;US)
Hardgrove, G.L., *See* Hingerty, B., 15:33200
Hardin, J.E., Initial testing of two DEMI [Driesbach Electromotive Inc.] Model 4E zinc-air rechargeable cells, 15:32439 (R;US)
Laboratory testing of chloride 3ET205 6 volt traction battery, 15:32438 (R;US)
See Burke, A.F., 15:32523
Hardison, D.L., *See* Estes, E.D., 15:33081
Hareland, W.A., Spatial distribution of atomic and molecular species in inductively coupled plasmas (ICP): By monochromatic imaging and image analysis, 15:32792 (BA;US)
Harkreader, S.A., *See* Lee, A.D., 15:32482
Harmon, M.E., *See* Bruns, D.A., 15:33124
Haroun, L.A., Multimedia assessment of health risks for the Weldon Spring site remedial action project, 15:32202 (R;US)
Harper-Slaboszewicz, V.J, Operation of a bidirectional voltage-dividing bremsstrahlung diode, 15:32918 (J;US)
Harrington, D., *See* Zheng, D.C., 15:33580
Harrington, M.S., *See* Voigt, J.A., 15:32898
Harris, T.L., *See* Tsang, M.N., 15:32505
Harrison, F.L., *See* Bishop, D.J., 15:32081
Hart, C.F., *See* Emin, D., 15:33647
Hart, J.M., *See* Boyes, J.D., 15:32945
Hart, K.M., Capillary suction-time tests on selected clays and shales. Master's thesis, 15:32128 (R;US)
Hartlieb, W., *See* Fett, T., 15:32614
Hartz, K.E., *See* Whelan, G., 15:32229
Harvey, T.F., A parametric investigation of electrical effects on aerosol scavenging by droplets over large fires, 15:33108 (R;US)
Hasegawa, K., *See* Abe, K., 15:32978
Hasegawa, T., *See* Saito, H., 15:32390
Hash, G.L., *See* Sexton, F.W., 15:33853
Hass, K.J., *See* Sexton, F.W., 15:33853
Hatakeyama, Mutuo, *See* Takeishi, Hideyo, 15:32371
Hatcher, R.D. Jr., *See* Walker, D., 15:33282
Hatori, Satoshi, Observation of the delayed proton decay by means of a recoil mass separator, 15:33405 (RA;JP;In Japanese)

Hauck, C.A., *See* Leung, K.N., 15:33366
Hauser, J., *See* Coffman, D., 15:33423
Havelka, S., *See* Jakesova, L., 15:32325
Haver, J.F., An oscillation detector used in the BPA power system disturbance monitor, 15:32431 (J;US)
Initial results in prony analysis of power system response signals, 15:32432 (J;US)
Hawkes, G.L., Verification and benchmarking of ABAQUS and PATRAN for heat transfer applications, 15:32863 (R;US)
Hawkins, C.A., *See* Roe, N.A., 15:33412
Hawkins, R.H., *See* McIntyre, P.F., 15:33123
Hawkins, R.J., *See* Sakai, Y., 15:32996
Hawthorne, A.R., *See* Dudney, C.S., 15:33111
Hayashi, Takaya, *See* Horiuchi, Ritoku, 15:33738
Hayess, E., *See* Weixelbaum, L., 15:33756
Haymaker, R.W., Convergence of the Langevin simulation for complex Gaussian integrals, 15:33523 (J;US)
Haynes, T.E., *See* Zuhr, R.A., 15:32627
He, X., Anomaly-free left-right-symmetric models with gauged baryon and lepton numbers, 15:33466 (J;US)
Heath, M.T., Visual animation of parallel algorithms for matrix computations, 15:33842 (R;US)
Hedemann, M.A., *See* Harper-Slaboszewicz, V.J., 15:32918
Hedrick, J.B., Minerals yearbook, 1988. Rare-earth minerals and metals, 15:32461 (R;US)
Heffner, R.H., *See* Takigawa, M, 15:32658
Hegazy, Y., *See* Rau, N.S., 15:32436
Hegde, M.S., *See* Jeon, Y., 15:32684
Heikkinen, D.W., *See* Davis, J.C., 15:32941
See Proctor, I.D., 15:32944
Heil, O., *See* Lencinas, S., 15:33597
Heinz, R., *See* Sambamurti, A., 15:33418
Heiser, J.H. III, *See* Kalb, P.D., 15:32199
Helayel Neto, J.A., Quantum gravity in two dimensions and the SL(2,R) current algebra, 15:33494 (R;XA)
Helayel-Neto, J.A., A higher-order analysis of the effects of breaking supersymmetry for non-linear σ-models, 15:33472 (R;BR)
Torsion-induced gauge superfield mass generation for gauge-invariant non-linear σ-models, 15:33473 (R;BR)
Heller, K., *See* James, C., 15:33414
Hellstern, E., Mechanism of achieving nanocrystalline AlRu by ball milling, 15:32566 (BA;US)
Hellwarth, R.W., Indices governing optical self-focusing and self-induced changes in the state of polarization in N_2, O_2, H_2, and Ar gases, 15:32765 (J;US)
Helton, J.C., *See* Iman, R.L., 15:32417, 15:32418
Hemond, H.F., Cumulative impacts on water-quality functions of wetlands, 15:33173 (R;US)
Henderson, D.J., *See* Vineyard, M.F., 15:33534
Hendron, A.J. Jr., *See* Thomas, R.L., 15:32160
Heneslan, M.A., *See* Hellwarth, R.W., 15:32765
Henning, W., *See* Beier, G., 15:33540
Henou, B., Energetic up-grading of wells in arterian basins, 15:32275 (R;FR;In French)
Henry, E.A., *See* Becker, J.A., 15:33558
Henry, R.E. Wu, Chun-Der, *See* Sharon, A., 15:32361
Hensel, D.S., *See* Hoffman, L., 15:32313
Henshall, G.A., Ambient-temperature creep failure of silver-aided diffusion bonds between steel, 15:32558 (R;US)
Hentea, T., *See* Ellingson, W.A., 15:32112
Herfjord, T., *See* Jakobsen, B., 15:32454
Hering, S.V., Southern California Air Quality Study (SCAQS) description of measurement activities. Final report, 15:33093 (R;US)
Hernandez, L. Jr., Sandia National Laboratories data engineering for DOE production agencies, 15:33863 (R;US)
Herndon, R.C., Proximity of Pennsylvania sanitary landfills to wetlands and deepwater habitats: Data on individual landfills, 15:33150 (R;US)
See Gebhard, R.L., 15:33151
Herring, J., *See* Jernigan, J.G., 15:32938
Herrmann, J.G., *See* Axetell, K., 15:32110, 15:32111
Hershkowitz, N., *See* Fiksel, G., 15:33834
See Roberts, D.R., 15:33796
Hertel, E.S., A comparison of CTH predictions with experimental armor/anti-armor data for long rod penetrators in two and three dimensions, 15:32873 (R;US)
Hertzler, C.L., *See* Wood, T.R., 15:33125
Herzog, F., Hydrologic modelling of the migration site at the Grimsel test site - the steady state, 15:33275 (R;CH)
Hetherington, C.J.D., The Berkeley atomic resolution microscope: An update, 15:33012 (BA;US)
Hetherington, M.G., *See* Cerezo, A., 15:32536
Hetrick, D.M., Comparison of an unsaturated soil zone model (SESOIL) predictions with a laboratory leaching experiment, 15:33136 (BA;US)
Hettich, R.L., Characterization of alkylated nucleosides by laser ionization Fourier transform mass spectrometry, 15:33199 (BA;US)
Heusermann, St., *See* Pahl, A., 15:33274
Heuze, F.E., Analysis of explosions in hard rocks: The power of discrete element modeling, 15:33039 (R;US)
Hewett, C.A., *See* Xia, W., 15:32760
Hewett, D.W., *See* Rutkowski, H.L., 15:33833
Heyde, K., Possible evidence for four-particle, four-hole excitations in ^{146}Gd, 15:33582 (J;US)
Heywood, J.B., *See* Cowart, J.S., 15:32519
Hidaka, Akihide, Sensitivity analyses on reflooding effect on the TMI-2 accident by the SCDAP code, 15:32369 (R;JP;In Japanese)
Hietala, S.L., Properties of films prepared from low surface area/density alumina-silica, 15:32615 (R;US)
Hietala, V.M., *See* Hietala, S.L., 15:32615
Hilde, T.W.C., *See* Payne, J., 15:32168, 15:32169, 15:32170
Hildebrandt, D., Impurity flux collection at the plasma edge of the tokamak MT-1, 15:33783 (R;HU)
Particle injection into the Castor tokamak by electric arcs, 15:33753 (RA;CS)
Hildemann, L.M., Urban modeling of organic aerosol source emissions, 15:33047 (R;US)
Hildenbrand, K.D., *See* Milkau, U., 15:33552
Hildum, J.S., *See* Fawley, W.M., 15:32926
Hill, C.T., *See* Bardeen, W.A., 15:33482
Hill, J.C., *See* Mach, H., 15:33544
Hill, W.R., *See* Boston, H.L., 15:33139
Hilliard, H.E., Minerals yearbook, 1988. Vanadium, 15:32459 (R;US)
Hilliard, N.D., *See* Whelan, G., 15:32229
Hingerty, B., Neutron diffraction of alpha, beta and gamma cyclodextrins: Hydrogen bonding patterns, 15:33200 (J;US)
Hinks, D.G., *See* Dabrowski, B., 15:32619, 15:32625
See Kimball, C.W., 15:32626
See Pei, S., 15:32687
Hinshaw, D.A., *See* Wagner, S.R., 15:33416
Hintsa, E.J., *See* Yokoyama, A., 15:32828
Hioe, F.T., *See* Carroll, C.E., 15:33718
Hippo, E.J., *See* Yen, S.C., 15:32040
Hirata, Kazuo, *See* Kukita, Yutaka, 15:32370
Hirayama, Hideo, *See* Ban, Syuichi, 15:32935
Hiroe, S., *See* Isler, R.C., 15:33806
Hirschmugl, C.J., *See* Williams, G.P., 15:32691
Hirshwald, W., *See* Stauf, G.T., 15:32735
Hirvonen, J.P., Unlubricated sliding properties of ion beam and excimer laser mixed Fe-Ti-C multilayered films, 15:32649 (BA;US)
Hirzel, D.G., *See* Chong, Y.P., 15:32946
Hisatsune, K., *See* Porter, W.D., 15:32585
Hitlin, D.G., *See* Coffman, D., 15:33423
Hitterman, R.L., *See* Shaked, H., 15:32688
Ho, K.M., *See* Chan, C.T., 15:32747
Ho, P., Laser studies of the SiH radical/surface interaction during deposition of a thin film, 15:32638 (BA;US)
Hoagland, R.G., An atomic model of crack tip deformation in aluminum using an embedded atom potential, 15:32587 (J;US)
Hobbins, R.R., Fission product release as a function of chemistry and fuel morphology, 15:32345 (R;US)
Hodge, C.A., Interaction of objects in manufacturing process simulation, 15:32852 (R;US)
Hodges, M.G., *See* Edgerton, E.S., 15:33092
Hodges, M.W., Effect of rib on burnout heat flux, 15:32339 (R;US)
Hoekenga, D.E., *See* Brainard, J.R., 15:33205

Hoffman, D.K., Time-dependent treatment of scattering: Integral equation approaches using the time-dependent amplitude density, 15:33385 (J;US)
Hoffman, F.O., [Finalization of the International Biospheric Model Validation Study]: Foreign trip report, April 22, 1990–April 28, 1990, 15:33067 (R;US)
Hoffman, G.W., *See* Aichinger, H.M., 15:32501
Hoffman, L., Estimated reductions in SO_2 emissions from the 100 largest electric utility power plant emitters through coal cleaning, 15:32313 (RA;US)
Hofler, H.J., *See* Hahn, H., 15:32624
Hofmann, B., Genesis, alteration and recent waterbearing structures of the Krunkelbach (Menzenschwand, Southern Black Forest) uranium deposit, 15:32192 (R;CH;In German)
Hofmann, J.V., *See* Fussmann, G., 15:33760, 15:33818
Hogan, R.E. Jr., A direct absorber reactor/receiver for solar thermal applications, 15:32290 (R;US)
Hogan, W.J., *See* Tobin, M.T., 15:33823
Hoganson, C.W., *See* Babcock, G.T., 15:32286
Holbrook, S.T., *See* Patton, J.T., 15:32133
Holland, A.F., *See* Shaughnessy, A.T., 15:33143, 15:33144
Holland, O.W., *See* El-Ghor, M.K., 15:32746
See Sjoreen, T.P., 15:32740
See Zuhr, R.A., 15:32627
Holland, R.F., Production of N_2^+ first negative emission by impact of 1-MeV H^0, H^+, and H^- on N_2, 15:33378 (J;US)
Holloman, M.E., *See* Otto, W.F., 15:32433
Holman, R., False vacuum decay in Jordan-Brans-Dicke cosmologies, 15:33285 (R;US)
Gravitational couplings of the inflaton in extended inflation, 15:33286 (R;US)
Holme, A.K., Entropy production in the relativistic heavy ion collisions, 15:33446 (R;HU)
Holroyd, R.A., The electron: Its properties and reactions: Principles and applications, 15:33343 (BA;US)
Holt, R.M., *See* Akervoll, I., 15:32131
Holtz, E. von, The search for high energy low vulnerability explosives, 15:33029 (R;US)
Honarpour, M.M., *See* Sharma, B., 15:32127
Honda, M., *See* Nishiizumi, K., 15:33316
Hong, Bong-Guen, *See* Kim, Chang-Bae, 15:33737
Hong, C.K., *See* Kwiat, P.G., 15:32767
Hong, J.W., The hydrogenated amorphous silicon reach-through avalanche photodiodes (a-Si:H RAPD's), 15:32744 (J;US)
Hongisto, O., *See* Tuomisto, H., 15:32383
Hooper, E.B., Characterization of disruptions in the Microwave Tokamak Experiment, MTX, 15:33787 (R;US)
Hoover, D.L., *See* Swadley, W.C., 15:33278
Hopke, P.K., *See* Landsberger, S., 15:33145
Hopkins, L.P., *See* Newell, C.J., 15:33149
Hopkins, P.L., LLUVIA: A program for one-dimensional, steady-state flow through partially saturated porous media, 15:32235 (R;US)
Hoque, A., *See* Talwar, I., 15:33587
Horen, D.J., *See* Beene, J.R., 15:33554
Horiuchi, Ritoku, Simulation study of self-organization and self-relaxation processes in plasma, 15:33738 (R;JP)
Horn, K.M., Hydrogen ion beam smoothening of oxygen roughened $\eta(001)$ surfaces, 15:32584 (BA;US)
Horschel, D.S., Synopsis of the results of a test of a reinforced concrete containment, 15:32395 (RA;US)
Horton, J.A., Effect of aluminum level on boron clustering in Ni_3Al, 15:32560 (BA;US)
See Liu, C.T., 15:32562
Horton, L.D., *See* Isler, R.C., 15:33806
Horton, W., *See* Kim, Chang-Bae, 15:33737
Horvath, I., Some notes on stationary vacuum space-times with shearing nongeodesic eigenrays, 15:33708 (R;HU)
Hoshino, Akira, *See* Takeishi, Hideyo, 15:32371
Hoshino, Katsumichi, A study on the heating and diagnostic of a tokamak plasma by electromagnetic waves of the electron cyclotron range of frequencies, 15:33763 (R;JP;In Japanese)
Hosoda, Yutaka, *See* Stram, D.O., 15:33227
Hosono, H., *See* Weeks, R.A., 15:32723
Hosoyama, K., *See* Kojima, Y., 15:32964
Houlton, R.J., *See* Cooke, D.W., 15:32900
Houpis, J.L.J., *See* Cowles, S., 15:33134
Houston, W.H., *See* Larson, J.A., 15:32335
Howard, J., A diagnostic for 2D density profiles in Heliac H-1, 15:33728 (RA;AU)
A novel scanning interferometer for two-dimensional plasma density measurements, 15:33730 (R;AU)
Howard, J.B., *See* McKinnon, J.T., 15:32835
Howe, G.B., *See* Estes, E.D., 15:33081
Howitt, D.G., *See* Bibler, N.E., 15:32728
Hoyt, M., *See* Hunt, G., 15:33068
Hrbek, J., *See* Shek, M., 15:32594
Hron, M., *See* Jakesova, L., 15:32325
Hsiau, H.N., *See* Baw, J.I., 15:32401
Hsu, C.J., *See* Diamond, D.J., 15:32402
Hu, Chi-yu, Muonic molecular structure, μ-sticking probability and fusion rates for muon catalyzed fusion: Final technical report, 15:33720 (R;US)
Hu, P., *See* Cai, W., 15:33645
Hu, S.J., Failure analysis of leakage current in plastic encapsulated packages, 15:33006 (R;XA)
Hu, Y., *See* Wagener, T.J., 15:32689
Huang Tao, *See* Huang Zheng, 15:33432
Huang Wuqun, *See* Chen Tianlun, 15:33489
Huang Zheng, A consistent analysis for the quark condensate $<\phi\ \phi>$ in QCD, 15:33432 (R;CN)
Huang, J.S., Phases and microstructures of carbon-implanted niobium, 15:32645 (BA;US)
Huang, L.K., Safety factor on the axis of a tokamak during Ohmically heated sawtoothing discharges from a localized measurement of circular polarization of the Li I 6708 A line, 15:33799 (J;US)
Huang, W.F., Evidence for a charge-density wave or spin-density wave in the Cu-O chains in $YBa_2Cu_3O_{7-x}$, 15:32678 (J;US)
Huang, Y., *See* Migliori, A., 15:32679
Huang, Y.H., *See* Lee, H.P., 15:32729
Hubele, J., *See* Milkau, U., 15:33552
Huckelbridge, A., *See* Stevenson, J.D., 15:32386
Huebner, W.F., *See* Sharp, C.M., 15:33320
Huffman, G.L., *See* Staley, L.J., 15:33086
Hughes, K.H., *See* Sexton, F.W., 15:33853
Hughes, R.C., *See* Carson, R.F., 15:33043
Hughes, R.J., *See* Goldman, T., 15:33713
Huguet, M., The overall configuration: Workshop held at JET on 25/26 September 1989, 15:33768 (RA;GB)
Hulgaard, T., Nitrous oxide emissions from Danish power plants, 15:32096 (R;DK)
Huling, S.G., Enhanced bioremediation utilizing hydrogen peroxide as a supplemental source of oxygen: A laboratory and field study. Final report, August 1987-November 1989, 15:32157 (R;US)
Hull, L.C., *See* Clemo, T.M., 15:32298
See Crockett, A.B., 15:32215
Hulse, G.R., *See* Robertson, W.M., 15:32598
Hulstrom, R.L., Solar resources, 15:32278 (B;US)
Humphreys, C.P., Identification of hydro data sources for use in mine plan review assessment of cumulative hydrologic impacts of surface mines Final report, 15:32104 (R;US)
Humphries, S. Jr., Sources of multiply charged ions for heavy-ion fusion, 15:33801 (J;US)
See Rutkowski, H.L., 15:33833
Hundley, M.F., Phase separation in a high-pressure-oxygenated $La_2CuO_{4+\delta}$ crystal: Evidence from anisotropic electronic transport and magnetic susceptibility, 15:32683 (J;US)
See Oseroff, S.B., 15:32677
Hung, Cheng-Hung, *See* Katz, J.L., 15:32860
Hunt, G., Ambient concentrations of PCDDs/PCDFs (polychlorinated dibenzodioxins/dibenzofurans) in the South Coast Air Basin. Final report, 1987-1990, 15:33068 (R;US)
Hupp, J.T., *See* Blackbourn, R.L., 15:32826
Hurd, A.J., *See* Hietala, S.L., 15:32615
Hurr, R.T., Estimating pumping time and ground-water withdrawals using energy-consumption data. Water-Resources Investigation, 15:32460 (R;US)
Husebye, S., *See* Barth, F., 15:32276
Hussein, M.S., *See* Pato, M.P., 15:33570

Hutchinson, D.P., Initial calorimetry experiments in the Physics Division, ORNL [Oak Ridge National Laboratory], 15:33723 (R;US)
Hutson, J.Y., *See* Brainard, J.R., 15:33205
Hwa, R.C., Fractal measures in multiparticle production, 15:33461 (J;US)
Hwang, I.T., *See* Baw, J.I., 15:32401
Hyde, J.M., *See* Cerezo, A., 15:32536

I

Iandelli, A., *See* Braicovich, L., 15:32769
Ibadov, S., Role of dust to gas production rate ratio in cometary physics, 15:33305 (RA;US)
Ice, G.E., *See* Bohanon, T.M., 15:32777
Idzorek, R., *See* Gregory, W.S., 15:32876
Igo, G., *See* Moshi, M.G., 15:33557
Iguchi, Tadashi, *See* Okubo, Tsutomu, 15:32373
Ikeuchi, S., *See* Norman, C.A., 15:33298
Ikuse, H., Feasibility testing of in situ vitrification of uranium-contaminated soils, 15:32244 (BA;US)
Ikushima, Takeshi, CRUSH: a simplified computer program for impact analysis of radioactive material transport casks, 15:33846 (R;JP)
SONATINA-2H: a computer program for seismic analysis of the two-dimensional horizontal slice HTGR core, 15:32324 (R;JP)
Ilgner, R.H., *See* Wise, M.B., 15:32782
Imai, Hisashi, *See* Matsuo, Hideto, 15:32703
Imai, T., Development of methanol reformer, 15:32264 (R;JP)
Development of synthetic gasoline-production process, 15:32272 (R;JP)
Imamura, M., *See* Nishiizumi, K., 15:33316
Iman, R.L., PARTITION: A program for defining the source term/consequence analysis interface in the NUREG–1150 probabilistic risk assessments: User's guide, 15:32417 (R;US)
PRAMIS: Probability Risk Assessment Model Integration System: User's guide, 15:32418 (R;US)
Imanishi, A., *See* Tokuda, N., 15:32923
Imanishi, B., Nuclear Landau-Zener promotion in the reactions of the system $^{13}C + {}^{16}O \rightarrow {}^{12}C + {}^{17}O$, 15:33531 (R;JP)
Imoru, C.O., On comparable L^p-norms of subadditive functions on topological groups, 15:33678 (R;XA)
Weighted norm inequalities for Riemann-Liouville fractional integral, 15:33677 (R;XA)
Inhaber, H., *See* Coleman, J., 15:32357
Ioffe, L., Superconductivity in mixed boson-fermion systems, 15:33652 (R;XA)
Irving, J.S., Cumulative impact assessment: A case study, 15:32277 (R;US)
Isenschmid, Ch., *See* Peters, Tj., 15:33263, 15:33264
Isgur, N., Influence of the B^* resonance on $\hat{B} \rightarrow \pi e \bar{\nu}_e$, 15:33455 (J;US)
Ishida, M.R., *See* Tsujimoto, Tadashi, 15:32254
Ishihara, Masahiro, *See* Yamashita, Kiyonobu, 15:32323
Ishitsuka, Etsuo, Experiments on tritium behavior in beryllium, (2): Tritium released by recoil and diffusion, 15:32547 (R;JP;In Japanese)
Ishizaka, Yuichi, Advanced marine reactor: Discussion of a soaking the reactor vessel in the water containment vessel upon the trial studies, 15:32327 (R;JP;In Japanese)
Isler, R.C., The effects of chromium and titanium gettering on the operation of the Advanced Toroidal Facility, 15:33806 (R;US)
Iso, Shuichi, *See* Takeishi, Hideyo, 15:32371
Isotani, S., Decay kinetics study of atomic hydrogen in a-Si:(H,O,N) and natural beryl, 15:33335 (R;BR)
Isoya, J., Fourier-transform and continuous-wave EPR studies of nickel in synthetic diamond: Site and spin multiplicity, 15:32775 (J;US)
Ito, K., Topology of singularities and phase diagram of N=2 superconformal field theories, 15:33492 (R;XA)
Trajectories of renormalization group flows on the phase diagram of N=2 superconformal field theories, 15:33491 (R;XA)
Itoh, Yasuyoshi, *See* Ishizaka, Yuichi, 15:32327
Iverson, J.R., Grid-interconnection requirements for small cogeneration systems. Final report, September 1985-December 1987, 15:32516 (R;US)
Grid-interconnection requirements for small cogeneration systems - Appendix. Final report, September 1985-December 1987, 15:32517 (R;US)
Ives, H.C., *See* Boyes, J.D., 15:32945

J

Jackiw, R., *See* Carroll, S.M., 15:33524
See Dunne, G.V., 15:33515
Jackson, J.P., *See* Windisch, D.E., 15:32732
Jackson, T., *See* Barrett, M., 15:32329
Jacobsen, R., *See* Rolfe, J., 15:32947
Jacobsen, T., Permeability patterns in some fluvial sandstones: An outcrop study from Yorkshire, North East England, 15:32124 (R;NO)
Jacobson, A.J., *See* Pei, S., 15:32687
Jacobson, H.W., *See* Leary, K.J., 15:32666
Jacobson, K.B., *See* Yoshida, H., 15:33231
Jacomino, V.M.F., *See* Gordon, A.M.P.L., 15:33600
Jacquinot, J., *See* Bhatnagar, V.P., 15:33774
Jagoda, J.I., *See* Zinn, B.T., 15:32183
Jain, V.K., Electron acoustic and magnetoacoustic modes in a magnetized beam plasma system, 15:33739 (R;XA)
Jakesova, L., HTGR reactor fuel, 15:32325 (R;CS;In Czech)
Jakobsen, B., A case study on optimal water management of small catchments: Aaros river in Norway, 15:32454 (R;NO)
Jakubka, K., *See* Hildebrandt, D., 15:33753
See Stoeckel, J., 15:33751
See Weixelbaum, L., 15:33756
James, C., Branching ratio and asymmetry for $\Xi^0 \rightarrow \Lambda\gamma$, 15:33414 (J;US)
James, R.B., Photoluminescence spectroscopy of thin indium-tin-oxide contracts on mercuric iodide substrates, 15:32632 (BA;US)
Jaminon, M., *See* Ripka, G., 15:33431
Jamison, J.D., Value-impact analysis of regulatory options for resolution of Generic Issue C-8: MSIV [Main Steam Isolation Valve] leakage and LCS [Leakage Control System] failure, 15:32419 (R;US)
Janda, K.C., Quantum state resolved desorption of CO from solid surfaces: Progress report, June 15, 1989–June 14, 1990, 15:33617 (R;US)
Janeschitz, G., *See* Fussmann, G., 15:33760, 15:33818
Jang, S., Entropy and Effective temperature in second RPA dynamics, 15:33574 (R;FR)
Janjusevic, M., Testing of laser-dressed atomic states, 15:33351 (J;US)
JANkowiak, R., Fluorescence line narrowing spectrometry: A versatile tool for the study of chemically initiated carcinogenesis, 15:33197 (BA;US)
Jankowski, A., *See* Tsakalakos, T., 15:32565
Jankowski, A.F., *See* Chaudhuri, J., 15:32570
Jannink, G., Glancing incidence neutron scattering, 15:33614 (R;FR)
Jansen, I.J., Soil survey versus crop production as a measure of soil productivity: Soil characteristics as predictors of corn and soybean yields, NCSS (National Cooperative Soil Survey) data base. Final report, 15:32102 (R;US)
Soil survey versus crop production as a measure of soil productivity: Soil-strength effects on row-crop yields. Final report, 15:32103 (R;US)
Janssens, R.V.F., *See* Vineyard, M.F., 15:33534
Jantzen, C.M., Prediction of glass durability as a function of environmental conditions, 15:32810 (BA;US)
Jarrell, M., Universal reduction of T_c in strong-coupling superconductors by a small concentration of magnetic impurities, 15:33660 (J;US)
Jaske, C.E., *See* Shah, V.N., 15:32407
Javadi, H.H.S., *See* Cooke, D.W., 15:32900
Jayanty, R.K.M., *See* Estes, E.D., 15:33081
Jean, J.M., *See* Belhadj, M., 15:33202
Jedelhauser, P., *See* Brenner, R.P., 15:32226

Jellison, G.E. Jr., Two-channel polarization modulation ellipsometer, 15:32998 (J;US)
Jena, P., *See* Li, Y., 15:33365
Jenista, J., Non-stationary computer model of the asymptotic region of an electric arc gas heater, 15:33742 (RA;CS)
Jenkins, M.G., *See* Ghosh, A., 15:32652
Jenkins, R.T., The BENCHMARK™ code: Simulation of hourly generation: User's guide, 15:32430 (R;US)
Jenkins, T., *See* Rolfe, J., 15:32947
Jenkovszky, L.L., *See* Boyko, V.G., 15:33296
Jenks, M.D., *See* Butterfield, C.P., 15:32306
Jennison, D.R., *See* Stechel, E.B., 15:33633
Jensen, A.G., Measurements at Aeroe Windmill park, 15:32307 (R;DK;In Danish)
Jensen, E.T., *See* Rous, P.J., 15:33649
Jensen, J., Natural gas requirements for electricity generation through 2000: Can the natural gas industry meet them?: Volume 1: Final report, 15:32174 (R;US)
Natural gas requirements for electricity generation through 2000: Can the natural gas industry meet them?: Volume 2, Appendix B, Gas supply issues: Final report, 15:32175 (R;US)
Jensen, L.C., *See* Dickinson, J.T., 15:33791
Jensen, T., *See* Barth, F., 15:32276
Jeon, Y., $BaBiO_3$ and the effect of potassium substitution using photoemission, 15:32684 (J;US)
Jepsen, O., *See* Gunnarsson, O., 15:32694
Jernigan, J.G., Performance measurements of hybrid PIN diode arrays, 15:32938 (R;US)
Jernigan, T.C., *See* Isler, R.C., 15:33806
Jervis, T.R., *See* Hirvonen, J.P., 15:32649
Jesson, D.E., *See* Pennycook, S.J., 15:32698
Jha, L.N., A review of self generated B-field in ICF corona, 15:33816 (R;XA)
Temporal behaviour of self generated magnetic field and its influence on inhibition of thermal flux in ICF plasma, 15:33815 (R;XA)
Ji, C., *See* Williams, R., 15:33594
Jiang, X.G., *See* Robertson, J.L., 15:32718
Jiao Rongzhou, *See* Zheng Hualing, 15:32195
Jin Ziying, *See* Tian Jiafu, 15:32330
Jing, T., *See* Cho, Gyuseong, 15:32977
Joffily, S., *See* Bediaga, I., 15:33428
Johnson, A.L., *See* Joyce, S.A., 15:32720
Johnson, A.S., *See* Roe, N.A., 15:33412
Johnson, B.M., *See* Bernstein, E.M., 15:33381
Johnson, C.E., *See* Fischer, A.K., 15:33805
Johnson, D.E., The Colliding Beams Sequencer, 15:32950 (BA;US)
Johnson, D.L., *See* Corley, J.P., 15:32911
Johnson, G.L., SSRL-PEP ring divertor channel entrance thermal stress analysis for new bending magnet loads, 15:32961 (R;US)
Johnson, J.A., *See* Carlson, N.M., 15:32848
Johnson, J.D., *See* Iman, R.L., 15:32417, 15:32418
Johnson, J.N., *See* Addessio, F.L., 15:33644
Johnson, P.D., Formation of excited hydrogen states in stimulated desorption from an alkali-promoted surface, 15:33637 (J;US)
Johnson, R.K., *See* McAllister, S.W., 15:32980
Johnson, R.L., *See* Powell, R.M., 15:33170
Johnson, R.M., *See* Rutkowski, H.L., 15:33833
Johnson, R.P., *See* Johnson, D.E., 15:32950
Johnson, R.W., Enhanced fluorescence and Raman analysis of DNA-adduct products, 15:32793 (BA;US)
Johnson, W., *See* Aston, D., 15:33410
Johnson, W.L., *See* Hellstern, E., 15:32566
Johnson, W.R., *See* Blundell, S.A., 15:33374
Johnston, D.C., *See* Miller, L.L., 15:32675
See Vaknin, D., 15:32676
Jones, C.W., *See* Battle, P.D., 15:32667
Jones, E.D., *See* Lott, J.A., 15:32758
Jones, K., *See* Moshi, M.G., 15:33557
Jones, K.M., *See* Blakeslee, A.E., 15:32733
Jones, K.W., *See* Bockman, R., 15:33212
Jones, R.V., *See* Meisenheimer, T.L., 15:32987
Jones, W.G., *See* Piacitelli, G.M., 15:33073
Jonker, M.J., *See* Roe, N.A., 15:33412
Jordan, D., *See* Otto, W.F., 15:32433
Jorgensen, J.D., *See* Dabrowski, B., 15:32619
See Pei, S., 15:32687
See Toby, B.H., 15:32630
Joslin, D.L., A new method for analyzing data from continuous depth-sensing microindentation tests, 15:32743 (J;US)
Jost, M.B., *See* Wagener, T.J., 15:32689
Jouve, A., Ressac program plants analytical experiments study of a code modelling the soil to plant transfer factor of cesium, 15:33117 (R;FR;In French)
Joy, D.C., *See* George, E.P., 15:32577
Joyce, S.A., Chemisorption of HF on silicon surfaces, 15:32720 (BA;US)
Judson, R.S., *See* Hoffman, D.K., 15:33385
Juettner, B., *See* Hildebrandt, D., 15:33753
Julius, J.A., *See* Bertucio, R.C., 15:32414, 15:32415
Jung, C.K., Search for long-lived massive neutrinos in *Z* decays, 15:33415 (J;US)
Jung, D., *See* Whangbo, M.-H., 15:32803
Jungst, R.G., *See* Skocypec, R.D., 15:33028

K

Kabe, A., *See* Kojima, Y., 15:32964
Kabler, M.N., *See* Long, J.P., 15:32756
Kaempfer, B., *See* Boyko, V.G., 15:33296
Kahan, O., *See* Chen, T.S., 15:33788
Kahn, B., *See* Asano, Tomohiro, 15:33603
Kahn, J.L., *See* Fuoss, P.H., 15:32721
Kahn, S.M., *See* Liedahl, D.A., 15:33325
Kaiser, E.A., *See* Bicknell, R., 15:33074
Kaiser, W.R., *See* Ayers, W.B., 15:32106
Kako, E., *See* Kojima, Y., 15:32964
Kalb, P.D., Encapsulation of mixed radioactive and hazardous waste contaminated incinerator ash in modified sulfur cement, 15:32199 (R;US)
Kallman, J.S., *See* Chong, Y.P., 15:32946
Kalvin, S., Tokamak radiation measurements by microchannel plate detector, 15:33755 (RA;CS)
Kam, F.B.K., Power reactor embrittlement data base, 15:32551 (RA;US)
See Miller, L.F., 15:32338
Kamecki-Duriez, L., Development of a new fluorometric detection test of sulfatoreducing bacteria type Desulfovibrio. Laboratory evaluation of chemical control of bacteria activity in biocorrosion, 15:32545 (R;FR;In French)
Kamegai, M., *See* Blattner, M.M., 15:33388
Kamionkowski, M., Searching for *CP* violation in "charge-blind" jets, 15:33483 (J;US)
Kammash, T., *See* Whetstone, S., 15:33828
Kampwirth, R.T., In-situ growth of superconducting films of Bi-Sr-Ca-Cu-O using magnetron sputtering, 15:32604 (R;US)
See Woo, K.C., 15:32661
Kanazawa, Takao, *See* Sunaga, Hiromi, 15:32933
Kanda, H., *See* Isoya, J., 15:32775
Kanemoto, G., *See* McManamy, T.J., 15:33807
Kang, J.H., *See* Woo, K.C., 15:32661
Kang, M.H., Atomic and electronic structure of the NiAl(111) surface, 15:32597 (J;US)
Kanter, E.P., *See* Belkacem, A., 15:33635
Kanyid, M.J., *See* Campbell, M.D., 15:32228
Kao, W.H., *See* Yang, J.M., 15:32582
Kaplan, M., *See* Boger, J., 15:33538
Kaplan, S.N., *See* Cho, Gyuseong, 15:32977
Kapusta, F., A unified description of the perturbative photon structure function in x space, 15:33449 (R;FR)
Kapusta, J., *See* Gatoff, G., 15:33514
Kapustka, L.A., Fiscal Year 1989 report: Initial performance evaluation of three bioassays modified for direct in-situ testing, 15:33244 (R;US)
Metals testing report: Metal content of environmental samples from Region 4, 15:33250 (R;US)
Kardashev, N.S., *See* Braginsky, V.B., 15:33673
Kardon, B., *See* Kalvin, S., 15:33755

Karim, K.R., *See* Bhalla, C.P., 15:33376
Karl, T.R., *See* Kukla, G.J., 15:33054
Karnitz, M.A., *See* Levins, W.P., 15:32484
Kartik, S., *A* dependence of J/ψ production in π^--nucleus collisions at 530 GeV/*c*, 15:33411 (J;US)
Karwowski, M., *See* Nehls, P., 15:33220
Kasai, Atsushi, *See* Amano, Hikaru, 15:33063
Kaschmitter, J.L., *See* Barfknecht, A.T., 15:32714
Kasi, S.R., *See* Robertson, J.L., 15:32672, 15:32718
Kassner, M.E., *See* Henshall, G.A., 15:32558
Kassner, T.F., *See* Shack, W.J., 15:32552
Kato, Kazuo, Calibration of Mg_2SiO_4(Tb) thermoluminescent dosimeters for use in determining diagnostic X-ray doses to Adult Health Study participants, 15:33604 (R;JP)
Kato, Y., *See* Daido, H., 15:32936
Katori, M., *See* Kawashima, N., 15:33608
Katsouleas, T., *See* Su, J.J., 15:32929
Katz, J.L., Initial studies of electric field effects on ceramic powder formation in flames, 15:32860 (R;US)
Kaufman, R.G., *See* Robertson, W.M., 15:32598
Kaufmann, E.N., The state of the industry, 15:33656 (J;US)
Kavvas, M.L., *See* Datta, B., 15:33171
Kawamura, Hiroshi, *See* Ishitsuka, Etsuo, 15:32547
Kawamura, S., *See* Suehiro, M., 15:32072
Kawasaki, M., *See* Vandentop, G.J., 15:32770
Kawashima, N., Systematic approach to critical phenomena by the extended variational method and coherent-anomaly method, 15:33608 (R;BR)
Kawata, S., Electron acceleration by an electromagnetic wave, 15:33340 (RA;JP)
Kaye, A., *See* Bhatnagar, V.P., 15:33774
Kaye, J.H., *See* Hara, F.T., 15:32230
Kazazian, H.H. Jr., *See* Cui, Xiangfeng, 15:33208
Kear, B.H., *See* McCandlish, L.E., 15:32617
Keating, R., *See* Peters, N., 15:32317
Kebede, A., *See* Cooke, D.W., 15:32693
Keck, J.C., *See* Cowart, J.S., 15:32519
Keegan, B., *See* Lazzaro, E., 15:33769
Kehoe, W., *See* Planeta, R., 15:33549
Kellhacker, M., *See* Watkins, M.L., 15:33766
Keller, K., *See* Fett, T., 15:32614
Keller, N., *See* Lencinas, S., 15:33597
Keller, R., *See* Langbein, K., 15:32955
See Leung, K.N., 15:32956
Keller, S.W., *See* Leary, K.J., 15:32666
Kelly, J.G., *See* Griffin, P.J., 15:32557
Kelly, J.H., *See* Smith, D.L., 15:32903
Kemmler, J., *See* Lencinas, S., 15:33597
Kempf, C.R., Decontamination impacts on solidification and waste disposal, 15:32200 (R;US)
Kenik, E.A., Phase stability of Ni_3Al_3 under electron irradiation, 15:32580 (BA;US)
Kennedy, K.G., Oberbauenstock (OBS) 1987: results of the hydrogeological testing program OBS-1, 15:33271 (R;CH)
Keogh, R.A., *See* Medina, R.J., 15:32078
Keohavong, P., Fidelity of DNA polymerases in DNA amplification, 15:33204 (J;US)
Kercher, J.R., *See* Cowles, S., 15:33134
Kerrigan, W.J., Analytical Data Management System (ADMS), 15:33859 (R;US)
Kerst, D.W., *See* Dexter, R.N., 15:33810
Kessler, D., *See* Yan, H., 15:33638
Keung, W., *See* Barger, V., 15:33463
Keusen, H.R., Grimsel test site: geology, 15:33267 (R;CH;In German)
Kever, H., *See* Reiter, D., 15:33779
Khanna, S.N., *See* Li, Y., 15:33365
Kheyfets, A., Covariant smoothed particle hydrodynamics on a curved background, 15:33715 (J;US)
Khveshchenko, D.V., Pairing with fractional angular and "spinor" gap, 15:33653 (R;XA)
Parity violation and superconductivity in doped Mott insulators, 15:33654 (R;XA)
Kiener, J., Coulomb-dissociation of 156 MeV ^{6}Li-projectiles, 15:33553 (R;DE;In German)
Kienle, P., *See* Beier, G., 15:33540
Kiggans, J.O. Jr., *See* Tiegs, T.N., 15:32605
Kilger, B., *See* Braeuer, V., 15:32224
Kilkenny, J.D., *See* Bell, P.M., 15:32979
Killough, S.M., *See* Beckerman, M., 15:32844
Kim, C.S., *See* Hagiwara, K., 15:33421
Kim, Chang-Bae, Fluctuation and thermal energy balance for drift-wave turbulence, 15:33737 (R;US)
Kim, D., Phonon temperature overshoot in GaAs excited by subpicosecond laser pulses, 15:33636 (J;US)
Kim, M.J., Composition and structure of native oxide on silicon by high resolution analytical electron microscopy, 15:32745 (J;US)
Kim, S.A., *See* Ledbetter, H.M., 15:32892
Kim, S.I., *See* Souzis, A.E., 15:33363
Kim, Y., Comments on relativistic correlation, 15:33346 (J;US)
Kimball, C.W, *See* Dabrowski, B., 15:32625
Kimball, C.W., Chemistry and superconducting behavior of Sb-substituted Bi/Pb-based oxides, 15:32626 (BA;US)
Kimrey, H.D. Jr., *See* Tiegs, T.N., 15:32605
Kinerson, R.S., *See* Hetrick, D.M., 15:33136
Kingler, J., Studies on the separation between higher-twist and minimum-twist in the photoproduction experiment WA69 at the CERN-OMEGA spectrometer, 15:33427 (R;DE;In German)
Kingon, A.I., *See* Ameen, M.S., 15:32635
Kini, A.M., *See* Whangbo, M.-H., 15:32803
Kirk, D.R., *See* Migliori, A., 15:32679
Kirk, M.A., *See* Bui, T.X., 15:32539
See Smalinskas, K., 15:32541
See Vetrano, J.S., 15:32540
Kirkpatrick, J.F., Diagnostic tools for reciprocating engine cogeneration systems. Phase 1, final report, June 1989-December 1989, 15:32508 (R;US)
Kirkpatrick, T.D., *See* Ozaki, C.B., 15:32252
Kishinevsky, M., *See* Fiksel, G., 15:33834
Kisker, D.W., *See* Fuoss, P.H., 15:32721
Kiss, A., *See* Bastrukov, S.I., 15:33341
Kiss, S., *See* Lipcsei, S., 15:32340
Kiar, B., *See* Hingerty, B., 15:33200
Klara, J.M., Mild gasification liquid characterization data for sytems modeling and assesment, 15:32080 (BA;US)
Klatt, J.L., *See* Bryan, R.P., 15:32774
Klatt, L.N., *See* Dale, J.M., 15:32791
Kleboth, P., *See* Peters, Tj., 15:33263, 15:33264
Klein, A., *See* Walet, N.R., 15:33585
Klein, H., *See* Langbein, K., 15:32955
Klein, R., *See* Furlong, M., 15:32060
Klein, S.R., *See* Weir, A.J., 15:33419
Kleinhanss, W., *See* Becker, H., 15:32268
Klem, J.F., *See* Lott, J.A., 15:32758
Klemm, R.A., Phenomenological model of the copper oxide superconductors, 15:33658 (J;US)
Klingler, W.B., *See* Durney, J.L., 15:32351
Klippert, T.E., *See* Eastman, J.A., 15:32622
See Epperson, J.E., 15:32621
Kloeck, W., Identification of solar nebula condensates in interplanetary dust particles and unequilibrated ordinary chondrites, 15:33306 (RA;US)
Klotz, D., Report on once-through column experiments with carbon-14, 15:32221 (R;DE;In German)
Klubek, B., Microbial removal of organic sulfur from coal (bacterial degradation of sulfur containing heterocyclic compounds), 15:32055 (RA;US)
Klueh, R.L., Irradiation effects on impact behavior of 12Cr-1MoVW and 2 1/4Cr-1Mo steels, 15:32538 (R;US)
Kluge, M., *See* Wolf, D., 15:33634
Knapp, J.A., *See* Follstaedt, D.M., 15:32573
Knezovich, J.P., *See* Bishop, D.J., 15:32081
Knight, J.L., *See* Wood, T.R., 15:33125
Kniss, T.A., *See* Williams, J.A., 15:32197
Knobloch, E., *See* Goldstein, H.F., 15:33392
Knott, D.P., *See* Beutler, D.E., 15:32937
Knudsen, P.D., *See* Hodge, C.A., 15:32852

Knutson, C.F., History and some potentials of oil shale cement, 15:32190 (R;US)
Ko, P., Vector-meson contributions to the processes $\gamma\gamma \to \pi^0\pi^0, \pi^+\pi^-$, $K_L \to \pi^0\gamma\gamma$, and $K^+ \to \pi^+\gamma\gamma$, 15:33465 (J;US)
Kobayashi, A.S., *See* Ghosh, A., 15:32652
Kobayashi, K., *See* Nishiizumi, K., 15:33316
Kodama, T., *See* Nazareth, R.A.M.S., 15:33564
Koegl, H., *See* Becker, H., 15:32268
Koehler, D., *See* Supkoff, D., 15:32282
Koehler, H.A., Time-resolved solid-state array imaging system: Developments and applications, 15:32261 (BA;US)
Koenig, J., *See* Bicknell, R., 15:33074
Koerner, H.J., *See* Beier, G., 15:33540
Kofke, D.A., A composition density functional theory for mixtures based upon an infinitely polydisperse reference. II. Freezing in hard sphere mixtures, 15:32819 (J;US)
Koga, J., Simulation of radial expansion of an electron beam injected into a background plasma, 15:32925 (R;US)
Kogan, Y.I., *See* Khveshchenko, D.V., 15:33653
Kogan, Ya.I., *See* Khveshchenko, D.V., 15:33654
Kohara, T., *See* Dalichaouch, Y., 15:32761
Kohfeldt, E., *See* Nehls, P., 15:33220
Kohl, C.P., *See* Nishiizumi, K., 15:33316
Kohno, Nobuaki, *See* Takeishi, Hideyo, 15:32371
Kolke, J., The effect of simultaneous electron and Kr^+ irradiation on amorphization of CuTi, 15:32575 (BA;US)
See Meng, W.J., 15:32574
Koizumi, Yasuo, *See* Kukita, Yutaka, 15:32370, 15:32372
Kojima, Hiroshi, Meteorological factors influencing on the radon concentrations in indoor and outdoor airs: Levels and risks, 15:33065 (RA;JP;In Japanese)
Kojima, Y., Upgrading of TRISTAN by superconducting RF system, 15:32964 (BA;US)
Kolacek, K., *See* Ripa, M., 15:33745, 15:33746
Kolb, E.W., *See* Amendola, L., 15:33287
See Copeland, E.J., 15:33291
See Holman, R., 15:33285, 15:33286
Komar, V., *See* Gryzinski, M., 15:33817
Komori, Takuji, *See* Takeishi, Hideyo, 15:32371
Komura, S., *See* Suehiro, M., 15:32072
Konjevic, R., Dependence of the phototropic response of Arabidopsis thaliana on fluence rate and wavelength, 15:33206 (J;US)
Konnert, M., *See* Franke, A., 15:33233
Kooijman, P., *See* Abachi, S., 15:33420
Koopman, R.P., *See* Schatz, K.W., 15:33056
Koopmann, G.H., *See* Reethof, G., 15:32311
Korpa, C.L., Flavor-mixing structure functions in the Nambu–Jona-Lasinio model, 15:33468 (J;US)
Korth, G.E., Metal matrix composites from dynamic consolidation of powder mixtures, 15:32544 (R;US)
Kortright, J.B., *See* Nguyen, T.D., 15:32579
Koseff, J.R., Complex cavities: Are two dimensions sufficient for computation?, 15:33391 (J;US)
Koski, O.H., *See* Windisch, C.F. Jr., 15:32511
Kostelecky, V.A., Reply to "Comment on 'Fine-structure and analytical quantum-defect wave functions' ", 15:33377 (J;US)
Kotulski, J.D., *See* Riley, D.J., 15:33036
Koundy, V., *See* Riviere, J., 15:32397
Kouno, S., Development of operation support system for flue-gas desulfurization plant, 15:32315 (R;JP)
See Suehiro, M., 15:32072
Kouri, D.J., *See* Hoffman, D.K., 15:33385
Koval, C.A., Mechanistic aspects of reductions by hot electrons in p-InP/acetonitrile photoelectrochemical cells, 15:32824 (J;US)
Kovar, D.G., *See* Vineyard, M.F., 15:33534
Kox, S., *See* Boger, J., 15:33538
Kozanecki, W., *See* Ford, W.T., 15:32927
Kozlov, S.M., Asymptotics of Laplace-Dirichlet integrals, 15:33693 (R;XA)
Krabill, R.H., *See* Stinton, D.P., 15:32071
Kracht, G., Energy in China, 15:32471 (R;FR;In French)
Kraemer, H.P., Investigations on cooling by forced flow of helium II driven by fountain effect pumps, 15:32865 (R;DE;In German)
Kramer, G., *See* Jernigan, J.G., 15:32938
Kramer, M.J., Effects of deformation on shielding currents in $YBa_2Cu_3O_{7-\delta}$, 15:32650 (BA;US)
See McCallum, R.W., 15:32660
Kraner, H., *See* Stevens, A., 15:32966
Krauss, A.R., *See* Ameen, M.S., 15:32635
Krelth, F., *See* Boehm, R.F., 15:32292
Krejci, A., K-lines in soft X-ray spectrum and the determination of plasma parameters of Ar Z-pinch, 15:33749 (RA;CS)
Kresin, V.Z., Major normal and superconducting parameters of high-T_c oxides, 15:32690 (J;US)
Krider, J., *See* Sambamurti, A., 15:33418
Krieg, R., *See* Eberle, F., 15:32389
Krilin, L., *See* Pavlo, P., 15:33754
Krishnan, K.M., Microanalytical and structural characterization of optical materials by electron microscopy and related spectroscopies, 15:32637 (BA;US)
Kroha, H., Prompt leptons from the decays of heavy quarks in the e^+e^- annihilation at energies of 35 and 43 GeV, 15:33408 (R;DE;In German)
Kroneberger, K., *See* Lencinas, S., 15:33597
Krouse, H.R., *See* Manowitz, B., 15:32164
Krousky, E., *See* Krejci, A., 15:33749
Krusin-Elbaum, L., *See* Malozemoff, A.P., 15:32647
Kruskal, C.P., *See* Siegel, H.J., 15:33856
Kryska, L., *See* Stoeckel, J., 15:33751
See Weixelbaum, L., 15:33756
Ku, K., *See* Payne, J., 15:32168, 15:32169, 15:32170
Kuan, P., Thermal behavior of cohesive debris beds in a degraded nuclear reactor, 15:32319 (R;US)
Kubat-Martin, K.A., *See* Migliori, A., 15:32679
Kubo, Tadashi, *See* Sugahara, Ryuhei, 15:32934
Kuehmichel, A., *See* Eckert, E.M., 15:33559
Kukita, Yutaka, Data report for ROSA-IV LSTF 5% cold leg break LOCA experiment Run SB-CL-08, 15:32370 (R;JP)
Data report for ROSA-IV LSTF 5% hot leg break experiment Run SB-HL-01, 15:32372 (R;JP)
Kukla, G.J., Multi-dimensional aspects of recent climate change in North America: Progress report, August 15, 1989–April 1, 1990, 15:33054 (R;US)
Kulander, K.C., Generation of optical harmonics by intense pulses of laser radiation. II. Single-atom spectrum for xenon, 15:33352 (J;US)
Kullberg, C.M., RELAP5 thermal-hydraulic analysis of the SNUPPS [Standardized Nuclear Unit Power Plant System] pressurized water reactor, 15:32422 (R;US)
Kullberg, M.L., *See* Cooper, E.A., 15:32802
Kumar, K., *See* Veskovic, M., 15:33595
Kunerth, D.C., *See* Lott, L.A., 15:32066
Kunkel, W.B., *See* Leung, K.N., 15:33366
See Smith, H.V. Jr., 15:33792
See Walther, S.R., 15:33347
Kuntze, W., *See* Bachmann, P., 15:32393
Kunz, P., *See* Aston, D., 15:33410
Kunz, P.D., *See* Oakley, D.S., 15:33556
Kurauchi, Nobuyoshi, *See* Watanabe, Katsutoshi, 15:32546
Kuroda, K., *See* Imai, T., 15:32264
Kuroyanagi, T., *See* Nakaya, R., 15:32976
Kurtz, S.R., *See* Biefeld, R.M., 15:32711
Kusano, Kanya, *See* Horiuchi, Ritoku, 15:33738
Kushner, M.J., *See* Pak, H., 15:33826
Kuska, M., Interferometric second-harmonic-generation autocorrelator for characterizing femtosecond pulses, 15:32993 (R;US)
Kusubov, A.S., *See* Glenn, L.A., 15:33033
Kuykendal, W.B., Volatile organic compound and particulate-matter speciation data base (for microcomputers). Data file, 15:33096 (R;US)
Kwak, J.F., *See* Halloran, J.W., 15:32616
Kwiat, P.G., Correlated two-photon interference in a dual-beam Michelson interferometer, 15:32767 (J;US)
Kwiatkowski, K., Heat partition in the *E/A*=8.5 MeV $^{74}Ge+^{165}Ho$ reaction, 15:33550 (J;US)
See Planeta, R., 15:33549
See Yennello, S.J., 15:33542
Kwok, R.S., *See* Cooke, D.W., 15:32693

Kwok, W.K., *See* Umezawa, A, 15:32655
Kwok, W.K., Flux-flow resistivity in single crystal $YBa_2Cu_3O_{7-\delta}$, 15:32654 (BA;US)
Kwon, I., Molecular-dynamics simulation of amorphous and epitaxial Si film growth on Si(111), 15:32773 (J;US)
Kwon, Y., *See* Aston, D., 15:33410

L

L'Huillier, M., Isoscalar giant resonances in a relativistic model, 15:33572 (R;FR)
La Mota, V. de, *See* Sebille, F., 15:33577
Lacks, S.A., *See* Cerritelli, S., 15:33203
LaFemina, J.P., New surface atomic structures for III-V(110)-p(1×1)-Sb(1ML): Chemical bonding and electronic structure, 15:32808 (R;US)
LaFlesh, R.C., Three-stage combustion (reburning) on a full-scale operating boiler in the USSR. Final report, March 1988-January 1990, 15:32316 (R;US)
LaGattuta, K.J., Laser effects in photoionization: numerical solution of coupled equations for a three-dimensional Coulomb potential, 15:33356 (J;US)
Lagowski, J., *See* Bliss, D.E., 15:32755
Lagrimini, L.M., [Molecular characteristics of the lignin forming peroxidase]: Progress report, 15:33195 (R;US)
Lai, C., *See* Supkoff, D., 15:32282
Lai, R., *See* Chang, K., 15:32772
Lai, S.K., Thermodynamics and structure of liquid alkali metals from the charged-hard-sphere reference fluid, 15:32805 (R;XA)
Lai, W.Y., *See* Su, Z.B., 15:33621
Laih, W.L., *See* Hong, J.W., 15:32744
Laine, R.M., *See* Wilson, R.B. Jr., 15:32050
Lairson, B, *See* Fork, D.K., 15:32631
Laiazissis, G.A., *See* Grypeos, M.E., 15:33568
Lallia, P.P., Performance expectations in the new configuration: Workshop held at JET on 25/26 September 1989, 15:33777 (RA;GB)
See Rebut, P.-H., 15:33765
Laiyani, S.B., Coal flotation and flocculation in the presence of humic acids, 15:32037 (RA;US)
Lam, D.J., *See* Bai, G.R., 15:32607
See Chang, H.L.M., 15:32606
Lambert, A., Sediment study - intermediate report 1988: disposal options for long lived radioactive waste in Swiss sedimentary formations: Executive summary, 15:32223 (R;CH)
Lambou, V.W., *See* Gebhard, R.L., 15:33151
See Herndon, R.C., 15:33150
Lambropoulos, P., *See* Charalambidis, D., 15:33372
See Tang, X., 15:33348
Lampe, R.L., National Performance Audit Program: Acid rain audits, 1988, 15:33082 (R;US)
Lamppa, D.L., *See* Voigt, J.A., 15:32898
Lance, R., *See* Pferdehirt, W., 15:33165
Lanczi, T., *See* Leitch, P., 15:32485
Landowne, S., *See* Dasso, C.H., 15:33590
Landron, C.O., *See* Baldwin, G.T., 15:33009
See Harper-Slaboszewicz, V.J., 15:32918
Landsberger, S., Determination of heavy metals on the Rock River through the analysis of sediments, 15:33145 (R;US)
Lang, T., *See* Nehls, P., 15:33220
Langan, J.P., *See* Wagner, W.T., 15:32387
Langbein, K., Analysis of the ion beam obtained from a small multicusp ion source, 15:32955 (J;US)
Lange, K., *See* Cui, Xiangfeng, 15:33208
Langford, S.C., *See* Dickinson, J.T., 15:33791
Langley, R.A., *See* Isler, R.C., 15:33806
Langston, D.C., *See* Laseter, W.A., 15:33062
Lankford, A.J., Computing and data handling requirements for SSC [Superconducting Super Collider] and LHC [Large Hadron Collider] experiments, 15:32939 (R;US)
Lapalomento, R.A., *See* Leary, K.J., 15:32666
Larkin, A.I., *See* Ioffe, L., 15:33652
Larraza, A., Dispersion relations for gravity waves in a deep fluid: Second sound in a stormy sea, 15:33395 (J;US)
Larsen, A., Wind turbine wake interference. A validation study. Vol. 1: Main text, 15:32302 (R;DK)
Wind turbine wake interference. A validation study. Vol. 2: Measurement results, 15:32303 (R;DK)
Larsen, R.P., A summary of prospects for methanol vehicles in the United States, 15:32525 (R;US)
Larson, D.C., [NEANDC/NEACRP Task Force on Nuclear Data Evaluation Cooperation]: Foreign trip report, April 28, 1990–May 2, 1990, 15:33529 (R;US)
Larson, J.A., Guidelines for the procurement and receipt of items for nuclear power plants (NCIG-15): Final report, 15:32395 (R;US)
Larson, N.M., *See* deSaussure, G., 15:33560
Larson, T.K., *See* Dimenna, R.A., 15:32358
Laseter, W.A., Pantex Plant site environmental report for calendar year 1988, 15:33062 (R;US)
Lashof, D.A., Policy options for stabilizing global climate. Draft report to congress. Executive Summary. Draft report, 15:33079 (R;US)
Laskey, J.W., *See* Phelps, P.V., 15:33249
Lasorsa, B.K., *See* Crecelius, E.A., 15:33188
Lassahn, G.D., Automatic, high-resolution analysis of low-noise fringes, 15:32992 (R;US)
Last, J.R., The JET divertor coil: Workshop held at JET on 25/26 September 1989, 15:33771 (RA;GB)
Lathrop, D., *See* Tullius, M., 15:32816
Lau, S.S., *See* Xia, W., 15:32760
Lau, Yuntung, Three-dimensional kinematic reconnection in the presence of field nulls and closed field lines, 15:33321 (J;US)
Laubach, S.E., *See* Ayers, W.B., 15:32106
Laudel, D.L., *See* Miller, S.J., 15:32095
Laurich, B.K., *See* Smith, D.L., 15:32715
Lavery, T.F., *See* Edgerton, E.S., 15:33092
Lawler, J.S., Impact of automated feeder reconfiguration on capacity utilization at the Athens Utilities Board, 15:32429 (R;US)
Lawrence, J.D., *See* Cerny, B.A., 15:33858
Lax, M., *See* Cai, W., 15:33645
Layman, L.R., *See* Niemczyk, T.M., 15:33010
Lazarz, N.M., *See* Chapman, L.D., 15:32742
Lazo, M.S., *See* Griffin, P.J., 15:32557
Lazzaro, E., Equilibrium configuration for a high current pumped divertor: Workshop held at JET on 25/26 September 1989, 15:33769 (RA;GB)
Le Hung Son, Some overdetermined systems of complex partial differential equations, 15:33690 (R;XA)
The Cousin problems for an overdetermined system of complex partial differential equations, 15:33688 (R;XA)
The Cousin problems in the viewpoint of partial differential equations, 15:33689 (R;XA)
Le Van Hop, The center of the enveloping algebra of the semidirect product of the Heisenberg Lie algebra h_n and a reductive lie algebra S the rank of which is equal to 1 or 2, 15:33679 (R;XA)
The combinatorics computation for Casimir operators of the symplectic Lie algebra and the application for determining the center of the enveloping algebra of a semidirect product, 15:33686 (R;XA)
Leal, L.C., *See* deSaussure, G., 15:33560
Leary, K.J., The production of high performance $YBa_2Cu_3O_7$ using nitrogen dioxide, 15:32666 (J;US)
Leboeuf, J., *See* Geary, J.L., 15:33795
Ledbetter, H.M., Elastic constants of two $Y_1Ba_2Cu_3O_x$ superconductors: x = 6.70 and 6.92, 15:32892 (BA;US)
Lee, A.D., Case study of the regional manufacturers' participation in the manufactured housing RCDP [Residential Construction Demonstration Project], 15:32482 (R;US)
Lee, B.W., *See* Dalichaouch, Y., 15:32670
See Maple, M.B., 15:32641
Lee, G.H., *See* Scheeline, A., 15:32790
Lee, H., *See* Dabrowski, B., 15:32625
See Kimball, C.W., 15:32626
Lee, H.P., The photoluminescence and TEM studies of patterned GaAs films on Si substrate grown by molecular beam epitaxy: Fundamentals, structure, and devices, 15:32729 (BA;US)
Lee, J.R., *See* Baldwin, G.T., 15:33009
See Harper-Slaboszewicz, V.J., 15:32918

Lee, K.S.H., System coupling and effects optimization, 15:32886 (R;US)
Lee, L.C., Cumulative impacts on wetlands: Linking scientific assessments and regulatory alternatives, 15:33175 (R;US)
Lee, M.C., *See* Payne, J., 15:32168, 15:32169, 15:32170
Lee, N.E., *See* Offord, D.A., 15:33192
Lee, P., *See* Chong, Y.P., 15:32946
See Fawley, W.M., 15:32926
Lee, S.C., Does nature place a fundamental limit on strength?, 15:33695 (R;XA)
Information loss down a black hole, 15:33293 (R;XA)
Lee, T.H., *See* Nozawa, S., 15:33581
Lee, Y.T., *See* Yokoyama, A., 15:32828
Leedy, R., *See* Baggett, M.J., 15:32931
Leeper, R.J., *See* Baldwin, G.T., 15:33009
Leggett, R.W., [Radiological protection of the public from intakes of radionuclides]: Foreign trip report, April 21, 1990–April 27, 1990, 15:33225 (R;US)
Legrand, B., *See* Jouve, A., 15:33117
Lehnert, B., A survey of theoretical research on the EXTRAP concept, 15:33786 (R;SE)
Lei, M., *See* Ledbetter, H.M., 15:32892
Leike, A., QED corrected extra Z boson effects at e^+e^- colliders, 15:33436 (R;XA)
Leitch, P., Energy requirements in Canadian restaurants: Final report, 15:32485 (R;CA)
Leith, C.E., Turbulence modeling in the SHALE code, 15:33386 (R;US)
Leith, D., *See* Aston, D., 15:33410
Leitzke, J., Roadmaps to sources of information on chemicals listed in the Emergency Planning Community and Community Right-To-Know Act also known as SARA (Superfund Amendments and Reauthorization Act) Title III, Section 313. Toxic Release Inventory (for microcomputers). Data file, 15:33095 (R;US)
Lejeune, A., *See* Mathiot, J.F., 15:33443
Lempert, G.D., *See* Robertson, J.L., 15:32672
Lencinas, S., Transport of fast electrons through thin foils, 15:33597 (J;US)
Lengsfield, B.H. III, *See* Rescigno, T.N., 15:33379
Lenhoff, R., *See* Brainard, J.R., 15:33205
Lennox, A.J., *See* Shea, M.F., 15:32915
Leong, K.H., *See* Barnhart, J.S., 15:32862
Leung, K.N., A high charge state multicusp ion source, 15:32956 (J;US)
Electron-suppression experiments in a small multicusp H^- source, 15:33366 (J;US)
See Smith, H.V. Jr., 15:33792
See Walther, S.R., 15:33347
See Williams, M.D., 15:33349
Leval, P., Entropy content from strange particle ratios in the E802 experiment, 15:33445 (R;HU)
See Holme, A.K., 15:33446
Levenson, J.B., *See* Walker, T.J., 15:32442
LeVine, M.J., New challenges for HEP computing: RHIC [Relativistic Heavy Ion Collider] and CEBAF [Continuous Electron Beam Accelerator Facility], 15:32906 (R;US)
Levins, W.P., Dust and ventilation effects on radiant barriers: Cooling season energy measurements: Final report, 15:32484 (R;US)
Levinson, L., *See* Aston, D., 15:33410
Levoy, N.F., *See* Leary, K.J., 15:32666
Levush, B., *See* Antonsen, T.M. Jr., 15:33732, 15:33808, 15:33809
Lewis, R.D., *See* LaFlesh, R.C., 15:32316
Lhenoret, P., *See* Eckert, E.M., 15:33559
Li Chunhua, *See* Mao Ruiguo, 15:32193
Li Shengfang, *See* Li Zhenping, 15:33599
Li Silin, *See* Deng Zhongguo, 15:32779
Li Zhenping, Survey and assessment of radioactivity level in Yangtze River water system, 15:33599 (R;CN;In Chinese)
Li, D., *See* Melloch, M.R., 15:32753
Li, G., *See* Reid, J., 15:33467
Li, Honghua, *See* Cui, Xiangfeng, 15:33208
Li, J., *See* Liu, J.C., 15:32725
Li, R., *See* Kartik, S., 15:33411
Li, R.M., *See* Eggert, K.G., 15:32101
Li, W., Magnetic order of the Cu planes and chains in $RBa_2Cu_3O_{6+x}$, 15:32685 (J;US)
See Lynn, J.W., 15:32680
Li, Y., Comment on "Charge exchange and metastability of small multiply charged gold clusters", 15:33365 (J;US)
Li, Y.M., *See* Su, Z.B., 15:33621
Liang, G., *See* Jeon, Y., 15:32684
Liang, W.S., *See* Eggert, K.G., 15:32101
Liba, B., *See* Ponevac, J., 15:32500
Libby, R., *See* Tokarz, R., 15:32404
Lichtl, R.L., *See* Cooke, D.W., 15:32693
Liddle, A.R., *See* Copeland, E.J., 15:33291
Liedahl, D.A., X-ray spectral signatures of photoionized plasmas, 15:33325 (J;US)
Liffman, K., Computer simulation of dust grain evolution, 15:33307 (RA;US)
Lifshitz, A., Rate constants for the reaction, $O + H_2O \rightarrow OH + OH$, over the temperature range, 1500–2400 K, by the flash photolysis-shock tube technique: A further consideration of the back reaction, 15:32781 (R;US)
Lifshitz, Y., *See* Robertson, J.L., 15:32672, 15:32718
Lightfoot, P., *See* Battle, P.D., 15:32667
Lilienfal-Weber, Z., *See* Waddill, G.D., 15:32600
Lilintal-Weber, Z., *See* Lee, H.P., 15:32729
Lima, D.A. de, Probability of ternary fission of ^{93}Nb and^{nat} Ag nuclei induced by 0.8-1.8 GeV photons, 15:33539 (R;BR)
Lin Zhifang, Quantum Ising model on hierarchical structures, 15:33624 (R;XA)
Lin, B., *See* Bohanon, T.M., 15:32777
Lin, C.S., *See* Koga, J., 15:32925
Lin, H., *See* Lee, H.P., 15:32729
Lin, S.H., Ultrafast time-resolved fluorescence spectroscopy, 15:32801 (J;US)
Lindau, I., *See* Braicovich, L., 15:32769
See Wahi, A.K., 15:32757
Lindner, M., *See* Bardeen, W.A., 15:33482
Lindstrom, M.M., *See* Marvin, U.B., 15:33283
Linehan, J.C., Variable temperature high speed spinning CP/MAS NMR studies of coals, 15:32087 (BA;US)
Link, M.A., *See* Fleming, B.A., 15:32058
Link, S.O., Evapotranspiration studies for protective barriers: FY 1988 status report, 15:32227 (R;US)
Lipcsei, S., Studies on vibration of fuel rods Pt. 1: Mechanical models of vibration of fuel rods in PWRs, 15:32340 (R;HU;In Hungarian)
Lissaman, P.B.S., *See* Edwards, L.K., 15:32491
List, F.A., *See* Oliver, W.C., 15:32628
Litke, D.W., *See* Hurr, R.T., 15:32460
Litterio, M., *See* Amendola, L., 15:33287
Littlefair, P.J., *See* Crisp, V.H.C., 15:32478
Liu Bingren, *See* Zheng Hualing, 15:32195
Liu Dechang, Digital image integration technique of multiple geoscience information system and its application, 15:32191 (R;CN;In Chinese)
Liu Mingde, *See* Mao Ruiguo, 15:32193
Liu, A.S., Precipitation of Ar, Kr and Xe in Ni at room temperature, 15:32730 (BA;US)
Liu, C., *See* Gao, B., 15:33360
Liu, C.T.,, *See* Yang, J.M., 15:32582
Liu, C.T., Structure maps and phase stability in $AlTi_3$ alloyed with rare-earth elements, 15:32562 (BA;US)
See Horton, J.A., 15:32560
See Takeyama, M., 15:32571
Liu, G., *See* Mordechai, S., 15:33535
Liu, J.C., In situ HVEM study of ion irradiation-induced grain growth in Au thin films, 15:32725 (BA;US)
Liu, J.Z., *See* Kwok, W.K., 15:32654
See Umezawa, A, 15:32655
Liu, S.H., *See* Huang, W.F., 15:32678
Liu, W., *See* Gottlieb, S., 15:33516
Liu, X., *See* Lee, H.P., 15:32729
Livengood, C.D., *See* Ohlsson, O.O., 15:32513
Lizzi, F., Total cross section of highly excited strings, 15:33499 (R;XA)
Loar, J.M., *See* Miller, C.W., 15:33190
Lobick, J.J., *See* Ellingson, W.A., 15:32629

Loeppke, G.E., Design and evaluation of lost-circulation materials for severe environments, 15:32300 (J;US)
Loercher, M., Measurement of the Lyman-alpha radiation at ionization manometers for determination of the hydrogen atom number density in fusion experiments, 15:33762 (R;DE;In German)
Logas, J., *See* Hahn, H., 15:32624
Lohse, T., *See* Ford, W.T., 15:32927
Loiseme, J.L., *See* Belanger, D.W., 15:33268, 15:33269
See Butler, G.A., 15:33270
See Pearson, F.J. Jr., 15:33266
Lomas, C., Proposals for a one tenth scale model test of the Sizewell B containment, 15:32391 (RA;US)
Long, J.P., Surface space-charge dynamics and surface recombination on silicon (111) surfaces measured with combined laser and synchrotron radiation, 15:32756 (J;US)
Long, W.H., *See* Windisch, D.E., 15:32732
Longcope, D.B. Jr., The prediction of loads on penetrators into rock via the spherical cavity expansion approximation, 15:33021 (R;US)
Longsine, D.E., *See* Belanger, D.W., 15:33268
See Butler, G.A., 15:33270
Loo, J.A., *See* Smith, R.D., 15:33198
Loong, C., *See* Miller, L.L., 15:32675
See Severing, A., 15:32591
Lopes, J.L., Dirac's equation as a geodesic in Riemann space, 15:33664 (R;BR)
Lopiano, D., *See* Moshi, M.G., 15:33557
Lorence, L.J. Jr., *See* Baldwin, G.T., 15:33009
See Harper-Slaboszewicz, V.J., 15:32918
Lott, J.A., Molecular beam epitaxy of $AlAs_{0.16}Sb_{0.84}$ and $Al_{0.8}Ga_{0.2}As_{0.14}Sb_{0.86}$ on InAs substrates, 15:32758 (J;US)
Lott, L.A., Acoustical and dynamic mechanical characterization of fiber-matrix interface bonds in ceramic composites, 15:32066 (R;US)
Lou Hai, *See* Zheng Weimin, 15:33217
Lou, B., *See* Williams, G.P., 15:32691
Louie, D.L.Y., *See* Murata, K.K., 15:32382
Louis Martinez, D., *See* Cabo, A., 15:33485
Loula, A.F.D., Dual and primal mixed Petrov-Galerkin finite element methods in heat transfer problems, 15:33711 (R;BR)
Finite element analysis of nonlinear creeping flows, 15:33710 (R;BR)
See Guerreiro, J.N.C., 15:33709
Love, P, *See* Leitch, P., 15:32485
Love, R., *See* Veselka, T.D., 15:32097
Lovelace, R.V.E., *See* Sulkanen, M.E., 15:33323
Loveland, W., Changes in target fragmentation mechanisms with increasing projectile energy in intermediate energy nuclear collisions, 15:33555 (J;US)
Lovell, T.W., *See* Dexter, R.N., 15:33810
Lowden, R.A., *See* Stinton, D.P., 15:32071
Lowndes, D.H., *See* Eres, D., 15:32739
Lowry, B., *See* Reden, K.F. von, 15:33417
Loyd, D.H., *See* Davis, J.C., 15:32941
Lu, B., *See* Torquato, S., 15:33389
Lubell, M.S., Parity violating weak neutral current effects in elastic $e^{-12}C$ scattering: Final report, August 15, 1987–May 14, 1989, 15:33530 (R;US)
Lubow, S.H., Shapes of star-gas waves in spiral galaxies, 15:33297 (R;US)
Lubume, M.S., *See* Chidume, C.E., 15:33687
Lucas, R., *See* Eckert, E.M., 15:33559
Luckas, W.J., *See* Metlay, D.S., 15:32403
Ludwig, H.R., Industrial-hygiene walk-through report, Cyprus Industrial Minerals Company, Bay Street Mill, Los Angeles, California, 15:33240 (R;US)
Luers, T.F., *See* Griffin, P.J., 15:32557
Luetken, C.A., String theory of Calabi-Yau compactifications, 15:33508 (R;DK)
Lui, S., *See* Kang, M.H., 15:32597
Lukacs, B., *See* Diosi, L., 15:33706
See Horvath, I., 15:33708
See Levai, P., 15:33445
Lundberg, B., *See* James, C., 15:33414
Lundin, C.D., HAZ liquation cracking behavior in newly developed lean 316 stainless steels, 15:32045 (R;US)
Lundschien, B., Parameters influencing porosity in sands and sandstones, 15:32125 (R;NO)
Lunsford, J.H., New directions for the catalytic conversion of methane. Annual report, January-December 1989, 15:32181 (R;US)
Luotonen, K., *See* Debaets, M., 15:32368
Lurie, D., *See* Wagner, W.T., 15:32387
Lusk, E.L., *See* Slaney, J.K., 15:33840
Lutsko, J.F., *See* Wolf, D., 15:33634
Lyagushkin, V.P., Complex experiment in plasma jet spraying of coatings, 15:33627 (RA;CS)
Lyman, W.J., Assessing UST corrective action technologies: Site assessment and selection of unsaturated zone treatment technologies. Report for October 1987-September 1989, 15:32159 (R;US)
Lynch, C.S., Design of a gun system for in-situ compressive strength measurements, 15:33037 (R;US)
Lynels, C.M., ERC sources for the production of highly charged ions (invited), 15:32952 (J;US)
Lynen, U., *See* Milkau, U., 15:33552
Lynn, J.W., Magnetic ordering of Nd in $(Nd,Ce)_2CuO_4$, 15:32680 (J;US)
See Li, W., 15:32685
Lyons, S., *See* Curry, R.D., 15:33827
Lyras, A., *See* Charalambidis, D., 15:33372
See Tang, X., 15:33348

M

Ma, J., X-ray structure of Cs-doped polyacetylene, 15:32768 (J;US)
Ma, R., *See* Piel, W.F. Jr., 15:33548
Ma, Y., Multiple sulfur sites in the Cu(100)$p(2\times2)$-S surface structure, 15:32601 (J;US)
MacCallum, J., Security classification of information concerning high-energy lasers. Instruction, 15:33017 (R;US)
MacCosbe, G.L., *See* Hernandez, L. Jr., 15:33863
MacCracken, M.C., A critical appraisal of model simulations, 15:33107 (R;US)
Climate Caucus report: Opportunities for bridging the gaps from effects to impacts, 15:33103 (R;US)
MacDonald, P.E., *See* Shah, V.N., 15:32407
MacDonell, M.M., *See* Haroun, L.A., 15:32202
Macek, J., *See* Cavagnero, M., 15:33367
MacGill, R.A., *See* Brown, I.G., 15:33353
Mach, H., Meson-exchange enhancement of the first-forbidden $^{96}Y^{g}(0^-)\rightarrow{}^{96}Zr^{g}(0^+)$ β transition: β decay of the low-spin isomer of ^{96}Y, 15:33543 (J;US)
Monopole strength and shape coexistence in the $A\geq100$ mass region, 15:33544 (J;US)
Subnanosecond lifetime measurements in Y and Sr nuclei and the saturation of deformation near $A=100$, 15:33546 (J;US)
Maciejewski, A.A., *See* Strip, D., 15:32856
Maddix, D.M., *See* Heuze, F.E., 15:33039
Madey, J.M.J., *See* Xie, M., 15:32904
Madey, T.E., *See* Joyce, S.A., 15:32720
Maeda, Kei-ichi, *See* Berkin, A.L., 15:33288
Maeda, Toyokazu, *See* Nakaya, R., 15:32976
Maestas, E., *See* McIntosh, T.W., 15:32247
Maez, M.A., *See* Cooke, D.W., 15:32900
Magalhaes, A.C.N. de, *See* Mariz, A.M., 15:33611
Magee, J.L., Theoretical aspects of radiation chemistry: Principles and applications, 15:32831 (BA;US)
See Chatterjee, A., 15:32832
Maget, P., *See* Henou, B., 15:32275
Magnuson, S.O., *See* Clemo, T.M., 15:32298
Magoon, L.B., Petroleum system: Status of research and methods, 1990. Bulletin, 15:32126 (R;US)
Magrudev, R., *See* Weeks, R.A., 15:32723
Maharana, J., *See* Das, A., 15:33518
Mahoney, A.R., *See* Skocypec, R.D., 15:33028

Mahrousseh, A., Inclusive results at 90°, at I.S.R., favourable to a diquark under-structure of the proton, and estimations of quantum chromodynamics, 15:33409 (R;FR;In French)
Maier, R., Beam diagnostic for COSY-Juelich, 15:32948 (BA;US)
Maier, R.J., Hydrogen/sulfur metabolism in the hyperthermophilic archaebacterium Pyrodictium brockii: Progress report, March 1, 1989–February 28, 1990, 15:33211 (R;US)
Maier, W.B. II, *See* Holland, R.F., 15:33378
See Robiscoe, R.T., 15:33041
Maillhiot, C., *See* LaFemina, J.P., 15:32808
See Smith, D.L., 15:32715
Maisel, B., *See* Hunt, G., 15:33068
Maiya, P.S., *See* Shack, W.J., 15:32552
Maj, W., *See* Aarts, J., 15:32596
Majercakova, A., *See* Ponevac, J., 15:32500
Makowski, M.A., *See* Hooper, E.B., 15:33787
Maley, M.P., Observation of thermally activated flux motion inweak link structures, 15:32656 (BA;US)
Malhotra, V.M., Coal-water interactions and preparation of dewatered ultrafine clean coal, 15:32038 (RA;US)
Malozemoff, A.P., Interlayer coupling in high temperature superconductors, 15:32647 (BA;US)
Malvagi, F., Renormalized equations for linear transport in stochastic media, 15:33393 (J;US)
Manabe, A., *See* Kawata, S., 15:33340
Mancini, H.L., *See* Wernsman, B., 15:33790
Mangano, M., *W*-boson-plus-two-jet production at the Fermilab Tevatron, 15:33453 (J;US)
Manida, S.N., Construction of mixed fermionic-bosonic string models in four dimensions, 15:33486 (R;XA)
Mann, J.M., *See* Browne, C.L., 15:32450
Manowitz, B., A sulfur isotope data analysis of crude oils from the Bolivar coastal fields (BCF), Venezuela, 15:32164 (BA;US)
Mao Ruiguo, The application of expandable polystyrene pellets as filter media to controlled filter in a uranium mill, 15:32193 (R;CN;In Chinese)
Mao, B., *See* Pope, M., 15:32813
Maple, M.B., Magnetism, specific heat, and pressure-dependent resistivity of the electron-doped compounds LnMCuO(Ln = Pr,Nd,Sm,Eu,Gd:M = Ce,Th), 15:32641 (BA;US)
See Dalichaouch, Y., 15:32670, 15:32761
See Weir, S.T., 15:32899
Mapoles, E.R., *See* Collins, G.W., 15:32674
Marchandise, H., *See* Griepink, B., 15:32094
Marciano, W.J., *See* Atwood, D., 15:33471
Marciniak, T.J., *See* Cole, R.L., 15:32502
Margolin, L.G., *See* Leith, C.E., 15:33386
Marion, J.E., *See* O'Dell, E.W., 15:32884
Mariz, A.M., Z(6) model: criticality and break-collapse method, 15:33611 (R;BR)
Markakis, J.M., *See* James, R.B., 15:32632
Markert, J.T., *See* Dalichaouch, Y., 15:32670
See Maple, M.B., 15:32641
Markham, S., *See* Kartik, S., 15:33411
Markuszewski, R., New analytical methods for organic sulfur in coal, 15:32085 (BA;US)
See Norton, G.A., 15:32093
See Straszheim, W.E., 15:32089
Marland, G., CO_2 emissions from production and combustion of fuel ethanol from corn, 15:32270 (R;US)
Marques-Bonham, S., Geometrical properties of an internal local octonionic space in a non-Riemannian manifold, 15:33662 (R;BR)
Marsh, K.V., *See* Meyer, R.A., 15:33547
Marshall, T., *See* Kartik, S., 15:33411
See Sambamurti, A., 15:33418
Marsily, L. de, Experimental determination of the flow speed of the Dogger geothermal aquifer in the Paris basin, 15:32294 (R;FR;In French)
Martensson, E., *See* Gelfand, N., 15:32914
Martin, C., *See* Graham, G., 15:32891
Martin, J., *See* Kartik, S., 15:33411
See Sambamurti, A., 15:33418
Martin, M.E., *See* Hardin, J.E., 15:32439
Martin, P., *See* Belmont, J.L., 15:32908
Martin, R.J., The importance of thermodynamics to the modeling of nitrogen combustion chemistry, 15:32838 (J;US)
Martin, S.J., Utilization of polymer viscoelastic properties in acoustic wave sensor applications, 15:33008 (R;US)
Martins, M.L., Criticality of the three-state chiral clock model: a renormalisation group study, 15:33609 (R;BR)
Martzolff, M., *See* Mathiot, J.F., 15:33443
Maruhn, J.A., *See* Bastrukov, S.I., 15:33576
Marvin, U.B., Cordierite-spinel troctolite, a new magnesium-rich lithology from the lunar highlands, 15:33283 (J;US)
Masin, J., *See* Furlong, M., 15:32059, 15:32060
Masin, J.G., *See* Fleming, B.A., 15:32058
See Furlong, M.W., 15:32061, 15:32062, 15:32063, 15:32064, 15:32065
Maslennikov, A.G., *See* David, F., 15:32787, 15:32833
Mason, T.O., *See* Cooper, E.A., 15:32802
Massalski, T.B., *See* Rizzo, H.F., 15:32569
Massen, S.E., *See* Grypeos, M.E., 15:33568
Masser, C.C., National Acid Precipitation Assessment Program (NAPAP) county-level alkaline emission estimates for unpaved roads. Dust Devils and wind erosion, 1985 (for microcomputers). Data file, 15:33094 (R;US)
Masters, D., *See* Shih, I., 15:32997
Mathey, O., The ion temperature gradient instability in a linear machine, 15:33797 (J;US)
Mathiot, J.F., Consistent three-nucleon forces in the nuclear many-body problem, 15:33443 (R;FR)
Matsumoto, Eiichi, *See* Hidaka, Akihide, 15:32369
Matsumoto, M., *See* Takeuchi, S., 15:33780
Matsunaga, Takeshi, *See* Amano, Hikaru, 15:33063
Matsuo, Hideto, Effect of high temperature neutron irradiation on physical properties of OGL-1 graphite block, 15:32703 (R;JP;In Japanese)
Matte, T.D., Health-hazard evaluation report HETA 87-371-1989, technical assistance to the Jamaican Ministry of Health, Kingston, Jamaica, 15:33075 (R;US)
Health-hazard evaluation report HETA 87-371-1986, technical assistance to the Jamaican Ministry of Health, Kingston, Jamaica, 15:33239 (R;US)
Matter, A., *See* Peters, Tj., 15:33263, 15:33264
Matthews, C.G., *See* Coffman, D., 15:33423
Matthews, D.L., Soft x-ray lasers, 15:32902 (J;US)
Matthews, T.G., *See* Wilson, D.L., 15:32481
Matzie, R.A., *See* Davis, G.A., 15:32379
Mauel, M.E., *See* Vijaya Sankar, M.K., 15:33733
Maurer, R.J., An aerial radiological survey of the Evans Area, US Army Communications-Electronics Command, Fort Monmouth, New Jersey: Date of survey, November 1988, 15:33055 (R;US)
May, M., *See* Chrien, R.E., 15:33533
Mayer, J.W., *See* Liu, J.C., 15:32725
Mayer, R., Efficient energy spectrometer for charged particle detection in surface studies, 15:32982 (J;US)
Mayer, W., *See* Beier, G., 15:33540
Mayer, W.A., *See* Beier, G., 15:33540
Mayergoyz, I.D., *See* Antonsen, T.M. Jr., 15:33732, 15:33808, 15:33809
Mazumdar, S., *See* Barlingay, C., 15:32692
Mazur, C., *See* Eckert, E.M., 15:33559
Mazurek, M.A., *See* Hildemann, L.M., 15:33047
Mc Nelsh, J.A., *See* Butler, G.A., 15:33270
McAllister, D.J., Surface acoustic wave (SAW) gas microsensor for SO_2. Final report, 15:33084 (R;US)
McAllister, S.W., Altitude-velocity envelope for a moving neutron detector, 15:32980 (R;US)
McBride, S.A., Cast coil transformer fire susceptibility and reliability study, 15:32880 (R;US)
McCallum, R.W., Superconducting properties of grain boundaries in dense, fine grained $YBa_2Cu_3O_x$, 15:32660 (BA;US)
See Kramer, M.J., 15:32650
McCandlish, L.E., Multicomponent ultrafine microstructures, 15:32617 (B;US)
McCann, L.D., *See* Bench, T.R., 15:33191

McCarthy, J.M., Deposition of dielectric optical coatings: A microstructural study of the deposited layers and interfaces, 15:32726 (BA;US)
McComick, D., *See* Rolfe, J., 15:32947
McConnell, J.W. Jr., Results of field testing of waste forms using lysimeters, 15:32217 (R;US)
McConnell, L., *See* Beall, C., 15:32162
McCune, W., Skolem functions and equality in automated deduction, 15:33841 (R;US)
McCurdy, C.W., *See* Rescigno, T.N., 15:33379
McDaniel, E.W., FUETAP concrete, 15:32250 (BA;US)
See Spence, R.D., 15:32245
McDonald, D.B., *See* Kampwirth, R.T., 15:32604
McDonald, J.P., *See* Gilmore, T.J., 15:32232
McDonell, W.R., *See* Wilhite, E.L., 15:32248
McDowell, E.M., *See* Schoengold, C.R., 15:33035
McElfresh, M., *See* Maley, M.P., 15:32656
McFarland, R.H., *See* Bernstein, E.M., 15:33381
McGill, J.A., *See* Ransome, R.D., 15:33532
McGlaun, J.M., *See* Hertel, E.S., 15:32873
McGrail, B.P., Obsidian hydration dating: Field, laboratory, and modeling results, 15:33279 (BA;US)
McGrory, J.B., *See* Piel, W.F. Jr., 15:33548
McGuire, R., *See* Holtz, E. von, 15:33029
See Pruneda, C., 15:33030
McHenry, M.E., *See* Maley, M.P., 15:32656
McIntosh, L., *See* Babcock, G.T., 15:32286
McIntosh, T.W., Initial operation of liquid waste treatment at the West Valley demonstration project, 15:32247 (BA;US)
McIntyre, P.F., Radionuclide uptake by pinetrees growing on lysimeters, 15:33123 (R;US)
Mckay, D.S., *See* Kloeck, W., 15:33306
McKee, R.A., *See* Oliver, W.C., 15:32628
McKennan, G., *See* Crisp, V.H.C., 15:32478
McKernan, S., *See* Carter, C.B., 15:32634
McKinley, I., *See* Lambert, A., 15:32223
McKinnon, J.T., The roles of PAH [polycyclic aromatic hydrocarbons] and acetylene in soot nucleation and growth, 15:32835 (R;US)
McLeod, R., *See* Barth, M., 15:32887
McLerran, L., *See* Carson, L., 15:33517
McLuckey, S.A., Ion injection and ms/ms studies with a 3-dimensional quadrupole, 15:32795 (BA;US)
See Asano, K.G., 15:33216
See Grant, B.C., 15:33023
See Van Berkel, G.J., 15:32165
McMahan, M.A., *See* Boger, J., 15:33538
See Kwiatkowski, K., 15:33550
See Planeta, R., 15:33549
McMahon, J.M., *See* Tomkins, B.A., 15:33256
McManamy, T.J., The insulation irradiation test program for the Compact Ignition Tokamak, 15:33807 (R;US)
McManus, K.P., *See* Bicknell, R., 15:33074
McManus, T.P., A decision-analysis process to support verification technology research and development, 15:32528 (R;US)
McMillan, C., Holographic measurement of ejecta from shocked metal surfaces, 15:32674 (BA;US)
McMillan, C.F., *See* Chaw, H.H., 15:32981
McNeill, D.H., Effect of changes in viewing window transmission on high-temperature Thomson scattering data, 15:33800 (J;US)
McParland, M., *See* Redey, L., 15:32441
McPheeters, C.E., *See* Minh, N.O., 15:32477
McSween, H.Y. Jr., Evolution of carbonaceous chondrite parent bodies: Insights into cometary nuclei, 15:33308 (RA;US)
McWhorter, P.J., Thermal emission model for the anneal of radiation-induced trapped holes, 15:32985 (R;US)
McWilliams, B.M., *See* Barfknecht, A.T., 15:32714
Mead, E. J., *See* Kaufmann, E.N., 15:33656
Medina, R.J., Co-processing and tar-sands resid: A new approach to alternative transportation fuels, 15:32078 (BA;US)
Meeks, K.D., *See* Trott, W.M., 15:32999
Mei, Z., *See* Violet, C.E., 15:32663
Meier, W.R., *See* Tobin, M.T., 15:33823
Meigs, G., *See* Ma, Y., 15:32601
Meike, A., Transmission electron microscopy study of illite/smectite mixed layers, 15:33129 (R;CH)
Meillot, E., Contribution to the study of a steam arc plasma. Application to pulverized coal gasification, 15:32070 (R;FR;In French)
Meiresonne, J., *See* Aarts, J., 15:32596
Meisenheimer, T.L., 1/*f* noise in irradiated MOS devices, 15:32987 (R;US)
Meissner, U., *See* Bernard, V., 15:33457
See Driscoll, D.E., 15:33460
See Korpa, C.L., 15:33468
Mele, E.J., *See* Kang, M.H., 15:32597
Melek, M., On the relation between the absolute parallelism spaces and spaces having a GL(4) connection, 15:33495 (R;XA)
Melim, V.J., *See* Dabrowski, B., 15:32625
See Kimball, C.W., 15:32626
Meller, R.E., Beam position monitors for the CESR linac, 15:32962 (BA;US)
Melloch, M.R., Molecular beam epitaxy regrowth by use of ammonium sulfide chemical treatments, 15:32753 (J;US)
Melnicoff, P.E., *See* Winans, R.E., 15:32108
Meng, W.J., Amorphization of Zr_3Al by hydrogenation and subsequent electron irradiation, 15:32574 (BA;US)
Menon, M.P., Investigation on the utilization of coal fly ash as amendment to compost for vegetation in acid soil: Progress report, March 16, 1989–April 15, 1990, 15:32092 (R;US)
Mercer, J.W., Basic data report for drillhole H-12 (Waste Isolation Pilot Plant-WIPP), 15:32236 (R;US)
Merchant, J.T., *See* Miner, G.E., 15:32284
Meroney, R.N., Analysis of vapor barrier experiments to evaluate their effectiveness as a means to mitigate HF concentrations, 15:32143 (R;US)
Mersman, K.E., Special Wasteform Lysimeter Program wasteform characteristics, 15:32214 (R;US)
Merts, A.L., *See* Collins, L.A., 15:33357
Meshii, M., *See* Koike, J., 15:32575
Metcalf, H., *See* Arnett, K., 15:33380
Metlay, D.S., Responding to emergencies: How organization and management make a difference, 15:32403 (RA;US)
Metz, D.J., Nuclear engineering research opportunities at Brookhaven National Laboratories, 15:32462 (R;US)
Mewhinney, J.A., Inhalation Toxicology Research Institute annual report, October 1, 1987–September 30, 1988, 15:33223 (R;US)
Meyer, Ch., *See* Peters, Tj., 15:33263, 15:33264
Meyer, E.A., *See* Cooke, D.W., 15:32900
Meyer, H.M. III, *See* Wagener, T.J., 15:32689
Meyer, J., *See* Peters, Tj., 15:33263, 15:33264
See Quentin, P., 15:33586
Meyer, R.A., Interacting-boson-fermion-fermion model description of $^{140}La_{83}$ and comparison with levels populated by beta decay and neutron capture, 15:33547 (J;US)
See Heyde, K., 15:33582
Meyyappan, A., *See* Patt, B.E., 15:32973
Miannay, D., Prediction of the brittle-ductile transition temperature shift, from irradiation experiments obtained in France, 15:32533 (R;FR;In French)
Michael, J.V., *See* Lifshitz, A., 15:32781
Micklich, B.J., *See* Chiu, H.K., 15:33804
Micklitz, H., *See* Saitovitch, E.B., 15:32602
Micu, C.J., *See* Weber, K.E., 15:32521
Migliori, A., Elastic constants and specific-heat measurements on single crystals of La_2CuO_4, 15:32679 (J;US)
Mignaco, A.J., Physical properties of the chiral quantum baryon, 15:33429 (R;BR)
Mignaco, J.A., The stability of the classical Skyrme model SU(2) hedgehog soliton, 15:33475 (R;BR)
Mihailsin, T., *See* Cooke, D.W., 15:32693
Mihlaczo, J.T., *See* Williams, J.A., 15:32197
Mikaelian, K.O., Turbulent energy at accelerating and shocked interfaces, 15:33390 (J;US)
Mikau, U., Fragment emission in the reaction $^{40}Ar+^{197}Au$ at E/A=30 and 220 MeV, 15:33552 (R;DE)
Mike, R., Major chemical accidents: Are we prepared?, 15:32443 (R;CA)
Millard, A., *See* Riviere, J., 15:32397

Miller, C.T., Modeling organic-contaminant sorption impacts on aquifer restoration, 15:33169 (R;US)
Miller, C.W., Examination of the impact of radioactive liquid effluent releases from the Rancho Seco Nuclear Power Plant, 15:33190 (J;US)
Miller, D.B., The response of MOV and SiC arresters to steep-front longer duration current pulses, 15:32434 (R;US)
Miller, D.J., *See* Kampwirth, R.T., 15:32604
Miller, D.L., *See* Wilk, R.D., 15:32520
Miller, D.P., Distance and clearance perception using forward-looking, vehicular television systems, 15:32496 (R;US)
Miller, J.D., *See* Clemo, T.M., 15:32298
See Cross, W.M., 15:32798
Miller, L.F., Neutron exposure parameters for the metallurgical test specimens in the sixth heavy-section steel irradiation series, 15:32338 (R;US)
Miller, L.L., Synthesis, structure, and properties of $Sr_2CuO_2Cl_2$, 15:32675 (J;US)
See Vaknin, D., 15:32676
Miller, L.M., *See* Bryan, R.P., 15:32774
Miller, M.K., *See* Cerezo, A., 15:32536
See Horton, J.A., 15:32560
Miller, R., *See* Hamak, J., 15:32182
Miller, S.J., Flue gas conditioning applied to fabric filtration, 15:32095 (BA;US)
Miller, S.L., *See* McWhorter, P.J., 15:32985
See Schwank, J.R., 15:32986
Miller, T., *See* Mueller, M.A., 15:32599
Miller, W.A., *See* Kheyfets, A., 15:33715
Miller, W.M., *See* McWhorter, P.J., 15:32985
Milomen, W.C.C., *See* Lima, D.A. de, 15:33539
Milton, K.A., Non-Abelian gauge theory on a finite-element lattice, 15:33522 (J;US)
Min, B.J., *See* Nakaya, R., 15:32976
Minahan, J.A., Comment on anomaly cancellation in the standard model, 15:33519 (J;US)
Minato, Kazuo, *See* Matsuo, Hideto, 15:32703
Mincer, A., *See* Coffman, D., 15:33423
Miner, G.E., Development of a point-contact solar cell using high-volume processing techniques: Final report, 15:32284 (R;US)
Minh, N.O., Monolithic solid oxide fuel-cell technology development. Phase 1A. Final report, February 1987-March 1989, 15:32477 (R;US)
Mini, S.M., *See* Alp, E.E., 15:33327
Mishra, S., A comparison of pressure-transient and tracer-concentration/time data for layered reservoirs under injection, 15:32134 (J;US)
Misono, S., *See* Imanishi, B., 15:33531
Misra, M.K., Pyrolytic behavior of a coal particle: Effect of unsteady state heating and temperation gradients, 15:32076 (BA;US)
Mital, S., *See* Stevenson, J.D., 15:32386
Mitarai, Shiro, *See* Nakaya, R., 15:32976
Mitchell, A.W., *See* Pei, S., 15:32687
Mitchell, M.A., *See* Halloran, J.W., 15:32616
Mitchell, T.E., *See* Halloran, J.W., 15:32616
Mitchell, W.J., *See* Lampe, R.L., 15:33082
Mittig, W., *See* Beene, J.R., 15:33554
Miyano, K., *See* Wahi, A.K., 15:32757
Mizrahi, S.S., Squeezed states representation; an λ-expansion of statistical mechanics, 15:33703 (R;BR)
Mizuma, Mituro, *See* Tsujimoto, Tadashi, 15:32254
Modine, F.A., *See* Jellison, G.E. Jr., 15:32998
Moe, M.K., Double-beta decay, 15:33536 (J;US)
Moerkirk, R.P., *See* Ravindra, N.M., 15:32737
Moerlins, J.E., *See* Gebhard, R.L., 15:33151
See Herndon, R.C., 15:33150
Moet-Ner Mautner, M., *See* Nelsen, S.F., 15:32823
Mogul, H., *See* Weeks, R.A., 15:32723
Mohammedi, N., On the unitarity of string propagation on SU(1,1), 15:33493 (R;XA)
Moir, R.W., *See* Tobin, M.T., 15:33823
Mokhtari, S., *See* Helayel Neto, J.A., 15:33494
See Helayel-Neto, J.A., 15:33473
Molander, W.A., Measurement of ground state copper density using hook spectroscopy, 15:32888 (BA;US)
Mole, M.L., High-performance liquid chromatographic assay of biphenyl metabolism by hepatocytes cultured in an embryo/hepatocyte co-culture medium, 15:33247 (R;US)
Molenkamp, C.R., Parameterization of aerosol scavenging in a convective cloud model, 15:33105 (R;US)
See Bradley, M.M., 15:33104
Molnar, G., *See* Mach, H., 15:33544
Moltz, D.M., *See* Akovali, Y.A., 15:33551
Mondy, L.A., *See* Abbott, J.R., 15:33632
See Rader, D.J., 15:33000
Monkhorst, H.J., *See* Stodden, C.D., 15:33368
Moodera, J.S., *See* Roshko, A., 15:32901
Moody, G., *See* Holtz, E. von, 15:33029
Moor, K.S., *See* Crockett, A.B., 15:32215
Moore, M.S., *See* deSaussure, G., 15:33560
Moore, N.L., *See* Deonigi, D.E., 15:32467
Moore, T.L., *See* Davis, J.C., 15:32941
See Proctor, I.D., 15:32944
See Southon, J.R., 15:32942
Moos, H.W., *See* Huang, L.K., 15:33799
Moran, B., *See* Glenn, L.A., 15:33033
Moran, T.F., *See* Xu, Y., 15:33371
Mordechai, S., Observation of double isovector giant dipole resonances from pion double charge exchange, 15:33535 (J;US)
Moreno, J.M., *See* del Aguila, F., 15:33454
Moretti, A.L., *See* Robertson, W.M., 15:32598
Morgan, L.G., *See* Windisch, C.F. Jr., 15:32511
Morgan, T.J., *See* Bernstein, E.M., 15:33381
Mori, Y., *See* Alton, G.D., 15:32957
Morimoto, T., *See* Tokuda, N., 15:32923
Morosin, B., *See* Ansaldo, E.J., 15:32633
See Halloran, J.W., 15:32616
Morris, A.L., *See* Norris, J.R., 15:32818
Morris, C.L., *See* Mordechai, S., 15:33535
See Oakley, D.S., 15:33556
See Ransome, R.D., 15:33532
Morris, D.E., Calcium-substituted Y-Ba-Cu-O superconductors with enhanced T_c synthesized at elevated oxygen pressures, 15:32686 (J;US)
Morris, R.C., *See* O'Dell, E.W., 15:32884
Morrissey, D.J., *See* Loveland, W., 15:33555
Morrow, J.C., *See* Baer, T., 15:32822
Morss, L., *See* Shaked, H., 15:32688
Morton, D., *See* Curry, R.D., 15:33827
Moser, L.V., Demonstration of noble gas collection using the cryogenic technique, 15:33060 (R;US)
Moses, D.J., *See* Boger, J., 15:33538
Moshl, M.G., Analyzing powers for $\vec{p}+^{208}Pb$ at large momentum transfers, 15:33557 (J;US)
Mosho, G.D., *See* Robinet, M.J., 15:33115
Moss, C.E., Health-hazard evaluation report HETA 88-229-1985, Ormet Corporation, Hannibal, Ohio, 15:33258 (R;US)
Moss, S.C., *See* Robertson, J.L., 15:32672, 15:32718
Moszynski, M., *See* Mach, H., 15:33544, 15:33546
Mota, F., *See* Whangbo, M.-H., 15:32803
Moudgil, B.M., A new approach in ultrapurification of coal by selective flocculation: Quarterly report, 15:32052 (R;US)
Moum, J., *See* Akervoll, I., 15:32131
Moussiaux, A., *See* Demaret, J., 15:33521
Mouton, W.J., *See* Edwards, L.K., 15:32491
Moxnes, E., Sustainable development, 15:32451 (R;NO)
Muchmore, C.B., *See* Chen, Hanlin, 15:32054
Mueller, M.A., Determination of the bulk band structure of Ag in Ag/Cu(111) quantum-well systems, 15:32599 (J;US)
Mueller, W.F.J., *See* Milkau, U., 15:33552
Mukai, Junko, *See* Nakaya, R., 15:32976
Mukhopadhyay, G., *See* Dey, J., 15:33569
Mukhopadhyay, P.K., Organic petrography, and organic geochemistry of Texas Tertiary coals in relation to depositional environment and hydrocarbon generation, 15:32082 (R;US)
Mulkers, A., Analysis of shared data structures for compile-time garbage collection in logic programs, 15:33843 (R;US)

Mullins, C.B., Trapping-mediated dissociative chemisorption of ethane on Ir(110)-(1×2), 15:32820 (J;US)
Mundim, K.C., *See* Giambiagi, M., 15:33326
Munger, A.C., *See* Begeal, D.R., 15:32437
Munyon, M.J., *See* Sholeen, C.M., 15:33114
Munz, D., *See* Fett, T., 15:32614
Mur, V.D., *See* Popov, V.S., 15:33333, 15:33334
Murakami, Hiroyori, *See* Kukita, Yutaka, 15:32372
Muramatsu, Y., *See* Saito, H., 15:32390
Murani, A.P., *See* Severing, A., 15:32591
Murao, Yoshio, *See* Okubo, Tsutomu, 15:32373
Murata, Isao, *See* Yamashita, Kiyonobu, 15:32352
Murata, K.K., Parametric CONTAIN calculations of the containment response of the Grand Gulf plant due to reactor pressure vessel failure at high pressure, 15:32382 (RA;US)
Murphy, C.E. Jr., *See* Gay, D.W., 15:33113
Murphy, J.B., *See* Blumberg, L.N., 15:32920
Musgrave, B., *See* Abachi, S., 15:33420
Musial, W.P., *See* Butterfield, C.P., 15:32306
Musket, R.G., *See* Huang, J.S., 15:32645
Muzio, L.J., *See* Teague, M.E., 15:32314
Myers, S.M., Deuterium interactions with ion-implanted oxygen in Cu and Au, 15:33344 (BA;US)
Myongsook S. Oh, Ammonia evolution from western and eastern oil shales, 15:32188 (BA;US)
Myszka, E., *See* Smith, G.V., 15:32057

N

Nabeshima, Kunihiko, *See* Shimazaki, Junya, 15:32344
Nagai, H., *See* Nishiizumi, K., 15:33316
Nagakura, F., *See* Imai, T., 15:32272
Nagpal, P., *See* Schmidt, B., 15:32586
Nagy, B., JANUS neutron irradiation of a mouse cell line containing a shuttle vector plasmid, 15:33221 (R;US)
Nakagawa, Shigeaki, *See* Shimazaki, Junya, 15:32344
See Yamashita, Kiyonobu, 15:32352
Nakai, S., *See* Daido, H., 15:32936
Nakajima, Hajime, *See* Watanabe, Katsutoshi, 15:32546
Nakajima, Ken, Development of the criticality accident analysis code, AGNES, 15:32849 (RA;JP;In Japanese)
Nakamura, A., Zero modes in vortex-fermion system with compact extra space, 15:33477 (R;JP)
Nakamura, Hisashi, Subcriticality monitering method based on the count-rate ratio, 15:32851 (RA;JP;In Japanese)
Nakanishi, Tsuneo, *See* Watanabe, Katsutoshi, 15:32546
Nakata, Hirokatsu, *See* Ishitsuka, Etsuo, 15:32547
Nakata, Tetsuo, *See* Yamashita, Kiyonobu, 15:32352
Nakaya, R., 4π Si ball, 15:32976 (RA;JP;In Japanese)
Nakazawa, Naohito, BRS invariant stochastic quantization of Einstein gravity, 15:33705 (R;JP)
BRS symmetry in stochastic quantization of the gravitational field, 15:33476 (R;JP)
Nanobashvili, S., *See* Stoeckel, J., 15:33751
Napolitano, L.M. Jr., *See* Siegel, H.J., 15:33856
Narasimhan, D., *See* O'Dell, E.W., 15:32884
Narayanan, A., *See* Boger, J., 15:33538
Narayanasamy, A., *See* Eastman, J.A., 15:32622
See Epperson, J.E., 15:32621
Nartker, T., *See* Baltz, D.W., 15:33838
Narwankar, P., *See* Morris, D.E., 15:32686
Nasby, R.D., *See* Schwank, J.R., 15:32986
Nastasi, M., *See* Hirvonen, J.P., 15:32649
See Kenik, E.A., 15:32580
See Parkins, D.M., 15:32896
Natale, A.A., *See* Almeida, L.D., 15:33503
Nathel, H., *See* Kwiat, P.G., 15:32767
Nation, W.G., *See* Siegel, H.J., 15:33856
Naulin, G., Phase transition in a shock loaded 304 stainless steel, 15:32535 (R;FR;In French)
Navrotski, G., *See* Shen, Q., 15:32588
Nazareth, R.A.M.S., Effective fire-tube and geometric scaling in proton-proton and proton-antiproton collisions, 15:33564 (R;BR)
Neal, M.J., *See* Halloran, J.W., 15:32616
Neel, J.V., *See* Chakraborty, R., 15:33209
Neff, D.E., *See* Meroney, R.N., 15:32143
Nehls, P., Investigations on the detection and prevention of DNA-lesions induced by ionizing irradiation, 15:33220 (R;DE;In German)
Nelli, P.H., Supercritical extraction-time-of-flight mass spectrometry with electron impact ionization of coal and coal model compounds, 15:32088 (BA;US)
See Winans, R.E., 15:32108
Nellis, W.J., *See* Weir, S.T., 15:32899
Nelsen, S.F., Proton affinities and pK_a values of tetraalkylhydrazines, 15:32823 (J;US)
Nelson, D.E., *See* Davis, J.C., 15:32941
See Southon, J.R., 15:32943
See Vogel, J.S., 15:33196
Nelson, D.J., *See* O'Dell, E.W., 15:32884
Nelson, E.C., *See* Hetherington, C.J.D., 15:33012
Nelson, J.S., *See* Yang, L.H., 15:32741
Nelson, L., Counterintelligence and operations security-support program for the Defense Nuclear Agency. Directive, 15:33020 (R;US)
Nelson, R., *See* Rolfe, J., 15:32947
Neri, F., Kinematic moment invariants for linear Hamiltonian systems, 15:33717 (J;US)
Nerlishi, Kazuo, *See* Stram, D.O., 15:33227
Ness, R.O. Jr., Development of an advanced, continuous mild gasification process for the production of co-products: Quarterly technical progress report, October–December 1989, 15:32051 (R;US)
Neufuss, K., Enhancement of the deposition rate of PAL 160 plasmatrons by using a multiple supply of spray material, 15:33629 (RA;CS;In Russian)
Neumeier, J.J., *See* Maple, M.B., 15:32641
Newcomer, D.R., *See* Gilmore, T.J., 15:32232
Newell, C.J., Oasis: Parameter estimation system for aquifer-restoration models. User's manual. Version 2.0. Report for October 1987-September 1989, 15:33149 (R;US)
Newsam, J.M., *See* Pei, S., 15:32687
Newton, M.A., *See* Prono, D.S., 15:32912
Nexsen, W., *See* Prono, D.S., 15:32912
Ngo, C., *See* Eckert, E.M., 15:33559
Nguyen Van Giai, *See* L'Huillier, M., 15:33572
Nguyen, T.D., High resolution electron microscopy study of as-prepared and annealed tungsten-carbon multilayers, 15:32579 (BA;US)
Nicholls, A., *See* Rhodes, W., 15:33201
Nichols, B.D., Three-dimensional computer modeling of particulate flow around dust monitors, 15:32877 (BA;US)
See Gregory, W.S., 15:32876
Nicholson, D.M., Structural energy differences in Al_3Ti: The role of tetragonal distortion in APB and twin energies, 15:32564 (BA;US)
Nickerson, L.G., *See* Smith, E.B., 15:32048
Nielson, K.K., A unified theory of radon transport in porous media: Model benchmark and soil parameter evaluations: Project annual report, 15:33140 (R;US)
Niemczyk, T.M., Influence of support gas composition on glow discharge properties, 15:33010 (BA;US)
Niemer, K.A., Modeling of runaway electron damage for the design of tokamak plasma facing components, 15:33822 (R;US)
Nierenburg, R., Wake deficit measurements on the Jess and Souza Ranches, Altamont Pass, 15:32305 (R;US)
Niessen, W., Simulation of the build-up phase of a high voltage low pressure gas discharge using Monte-Carlo-methods, 15:32975 (R;DE;In German)
Nieto, M.M., *See* Goldman, T., 15:33713
See Kostelecky, V.A., 15:33377
Nieves, J.F., *See* D'Olivo, J.C., 15:33459
Nikias, C.L., *See* Windisch, C.F. Jr., 15:32511
Nikula, K.J., *See* Bechtold, W.E., 15:33224
Nir, Y., *See* Dib, C.O., 15:33481
Nishida, Y., *See* Otsuka, K., 15:32924
See Taura, T., 15:32909
Nishizumi, K., ^{10}Be profiles in lunar surface rock 68815, 15:33316 (BA;US)

Nishikawa, Kyoji, *See* Horiuchi, Ritoku, 15:33738
Nishimoto, H., *See* Curry, R.D., 15:33827
Nishimura, Hideo, *See* Okamoto, Tsuyoshi, 15:33847
Nishimura, I., Biological effects of combined exposure to coal fly ash and nitrogen dioxide, 15:32122 (R;JP;In Japanese)
Nishina, Kojiro, *See* Yamane, Yoshihiro, 15:32850
Nishioka, T., *See* Al-Jassim, M.M., 15:32724
Nitschke, J.M., *See* Akovali, Y.A., 15:33551
Nix, R.M., *See* Vandentop, G.J., 15:32770
Noble, A., *See* Adam, G., 15:33682
Noetzold, D., Gravitational effects of global textures, 15:33289 (R;US)
Noll, P., Stabilisation of the vertical plasma position: Workshop held at JET on 25/26 September 1989, 15:33770 (RA;GB)
Nolte, D.D., *See* Bliss, D.E., 15:32755
Nonaka, A., *See* Takumi, K., 15:32388
Nonogaki, Y., *See* Kouno, S., 15:32315
Noonan, D.C., *See* Lyman, W.J., 15:32159
Nordlander, P., *See* Johnson, P.D., 15:33637
Norman, C.A., The disk-halo connection and the nature of the interstellar medium, 15:33298 (R;US)
Norman, M.R., Orbital polarization and the insulating gap in the transition-metal oxides, 15:32673 (J;US)
Nornes, E.H., *See* Bjerketvedt, D., 15:32146
Norris, J.R., A general model of electron spin polarization arising from the interactions within radical pairs, 15:32818 (J;US)
See Isoya, J., 15:32775
Norris, W.E., *See* Wagner, W.T., 15:32387
Norton, G.A., The removal and control of trace elements in coal and coal wastes, 15:32093 (RA;US)
Norton, M., KD*P frequency doubler for high average power applications, 15:32885 (R;US)
Noun, R.J., *See* Deonigi, D.E., 15:32467
Novello, M., Viscous causal cosmologies, 15:33284 (R;BR)
See Elbaz, E., 15:33712
Novickas, A., *See* Veselka, T.D., 15:32097
Novikov, I.D., *See* Braginsky, V.B., 15:33673
Novoa, J.J., *See* Whangbo, M.-H., 15:32803
Nowick, A.S., Protons and lattice defects in perovskite-related oxides: Progress report, July 1, 1989–April 30, 1990, 15:32611 (R;US)
Nozawa, S., Neutral pion photoproduction on the nucleon near threshold, 15:33581 (J;US)
Nozik, A.J., *See* Gessert, T.A., 15:32762
Nucho, R., Mechanisms of ^{60}Co uptake and loss by Scenedesmus obliquus and transfer to two benthic organisms, 15:33138 (R;FR;In French)
Nugent, A., *See* Beall, C., 15:32162
Numark, N.J., Public perception and acceptance of the siting of nuclear waste facilities in seven countries, 15:32218 (R;US)
Nuroh, K., On the dynamic polarizability of atoms, 15:33332 (R;XA)

O

O'Dell, E.W., Development of a large scale Nd:YAG growth process, 15:32884 (R;US)
O'Donnell, J.M., *See* Mordechai, S., 15:33535
O'Hara, J., The effects of local control station design variation on plant risk, 15:32410 (RA;US)
O'Keefe, M.A., *See* Rai, R.S., 15:32636
O'Neill, R.V., *See* Turner, M.G., 15:33051
O'Rourke, T.P., *See* Bruns, D.A., 15:33124
O'Shea, P.G., *See* Holland, R.F., 15:33378
Oakley, D.S., Coulomb-nuclear interference in pion inelastic scattering, 15:33556 (J;US)
Oberacker, V.E., *See* Strayer, M.R., 15:33593
Occhionero, F., *See* Amendola, L., 15:33287
Oehm, W., Integrodifferential equation approach. Pt. 2. Triton and α-particle wave functions. Graphical plots, 15:33563 (R;DE)
Oertzen, W. von, *See* Imanishi, B., 15:33531
Offord, D.A., Preparative purification of Trichoderma reesei native and "core" Cellobiohydrolase I by electrophoresis and chromatofocussing, 15:33192 (R;US)
Oglesby, C.S., *See* Bernstein, E.M., 15:33381
Oglesby, L.A., *See* Mole, M.L., 15:33247
Ohishi, T., *See* Kouno, S., 15:32315
Ohlsson, O.O., Results of emissions and ash testing in full-scale co-combustion tests of binder-enhanced dRDF pellets and high-sulfur coal, 15:32513 (R;US)
Okada, K., Present status of $\beta\beta$ decay measurements, 15:33404 (RA;JP)
Okamoto, P.R., *See* Koike, J., 15:32575
See Meng, W.J., 15:32574
See Wolf, D., 15:33634
Okamoto, Tsuyoshi, CCS-I: a code to analyze a dynamic behavior of uranium enrichment process in a centrifuge cascade: An application to the safeguards effectiveness assessment, 15:33847 (R;JP)
Okseniuk, A.M., *See* Cerny, B.A., 15:33858
Okubo, Tsutomu, Evaluation report on CCTF Core-II reflood test C2-AA2 (Run 58): Investigation of downcomer injection effects, 15:32373 (R;JP)
Olander, D.R., *See* Abrefah, J., 15:32771, 15:32834
Olcese, G.L., *See* Braicovich, L., 15:32769
Olesik, S., *See* Baer, T., 15:32822
Olexsey, R.A., *See* Staley, L.J., 15:33086
Oliveira, H.P. de, *See* Novello, M., 15:33284
Oliver, G., *See* Spelt, P.F., 15:32843
Oliver, W.C., The development of alloys based on Ni_3Si, 15:32578 (BA;US)
The influence of thickness and wavelength on the mechanical properties of a compositionally modulated ceramic thin film, 15:32628 (BA;US)
See Joslin, D.L., 15:32743
See Porter, W.D., 15:32585
Olmstead, M.A., Chemical bonding and lattice mismatch in semiconductor-insulator heteroepitaxy: SrFsub 2on Si(111): Fundamentals, structure, and devices, 15:32736 (BA;US)
Olson, C.G., *See* Wieliczka, D.M., 15:32751
Olson, J.M., *See* Blakeslee, A.E., 15:32733
Olson, J.S., *See* Miner, G.E., 15:32284
Olsson, Olle, Radar investigations at the Saltsjoetunnel - predictions and validation, 15:32238 (R;SE)
Ong, C.S., *See* Turner, C.D., 15:33189
Ong, R.A., *See* Wagner, S.R., 15:33416
Onihashi, H., *See* Taura, T., 15:32909
Oort, H. van, *See* Larsen, A., 15:32302, 15:32303
Oosawa, Yasunobu, *See* Sugahara, Ryuhei, 15:32934
Opgenorth, D., *See* Supkoff, D., 15:32282
Orel, A.E., Variational expressions for first-order properties involving continuum wave functions, 15:33373 (J;US)
Oren, W., *See* Bell, B., 15:32910
Orlob, G.T., *See* Datta, B., 15:33171
Ornellas, D.L., *See* Tao, W.C., 15:33031
Orr, F.M. Jr., *See* Walsh, B.W., 15:32135
Orr, J.L., Investigation of effects of 60-Hz electric and magnetic fields on operant and social behavior and on the neuroendocrine system of nonhuman primates: Annual report, 15:32435 (R;US)
Orsini, G., Analysis predictions vs. test results of the 1:6-scale reinforced concrete containment tested at Sandia National Laboratories, 15:32398 (RA;US)
Ortale, C., *See* James, R.B., 15:32632
Orth, C.D., *See* Tobin, M.T., 15:33823
Ortiz, M.G., *See* Hanson, R.G., 15:32359
Orzechowski, T.J., *See* Fawley, W.M., 15:32926
Osborn, C.T., *See* Young, C.E., 15:32457
Oseroff, S.B., Complex magnetic properties of the rare-earth copper oxides, R_2CuO_4, observed via measurements of the dc and ac magnetization, EPR, microwave magnetoabsorption, and specific heat, 15:32677 (J;US)
Osetek, D.J., *See* Hobbins, R.R., 15:32345
Osher, J.E., *See* Chaw, H.H., 15:32981
Osterheld, A.L., *See* Liedahl, D.A., 15:33325
Otake, Masanori, Radiation-related posterior lenticular opacities in Hiroshima and Nagasaki atomic bomb survivors based on T65DR and DS86 dosimetry systems, 15:33228 (R;JP)
Otsuka, K., Numerical simulation of multi-EM-beam electron accelerator, 15:32924 (RA;JP)
See Taura, T., 15:32909

Otsuka, N., *See* Melloch, M.R., 15:32753
Ott, H.R., *See* Felder, E., 15:32581
Ott, K.C., *See* Takigawa, M, 15:32658
Otto, W.F., Power-transmission device, 15:32433 (P;US)
Ovchinnikov, A.A., *See* Aliev, T.M., 15:33437
Ovchinnikov, Yu.N., *See* Ioffe, L., 15:33652
Overseth, O.E., *See* James, C., 15:33414
Oyamada, O., *See* Saito, H., 15:32390
Ozaki, C.B., Low-level radioactive waste management in the United States, 15:32252 (BA;US)
Ozkaynak, H., *See* Fingleton, D. J., 15:32151

P

Pace, T.G., *See* Axetell, K., 15:32110, 15:32111
Pack, R.T., *See* Archer, B.J., 15:33369
See El-Sheikh, S.M., 15:32817
Paetzold, S., Morphological and biochemical investigations into the effects of quartz on bovine alveolar macrophages (BAM) and their organelles, 15:33232 (R;DE;In German)
Paff, S.W., *See* Price, R.L., 15:32444
Pagano, T., *See* Garner, J.H.B., 15:33085
Pahl, A., Rock stress investigations, 15:33274 (R;CH;In German)
See Braeuer, V., 15:32224
Paige, H.W., *See* Numark, N.J., 15:32218
Painter, P.B., *See* Gammage, R.B., 15:33257
Pak, H., A model for the optically triggered pseudo-spark thyratron using local field and beam-bulk methods, 15:33826 (BA;US)
Pal, P.B., *See* D'Olivo, J.C., 15:33459
Palenzona, A., *See* Braicovich, L., 15:32769
Paliadino, B.E., Mass differences of light hadron isomultiplets, 15:33440 (R;BR)
Palmer, B.A., *See* Niemczyk, T.M., 15:33010
Palmer, P.E., *See* Beaudry, B.J., 15:32799
Palmer, R.E., *See* Rous, P.J., 15:33649
Palmqvist, Kai, *See* Olsson, Olle, 15:32238
Pan, C., *See* Gao, B., 15:33360
Pan, H.C., Nitrogen doping of ZnO prepared by organometallic chemical vapor deposition, 15:32642 (BA;US)
Pandharipande, V.R., *See* Pieper, S.C., 15:33583
Pang, H.B., How to interpret the validity of the single band model?, 15:33620 (R;XA)
Pankov, A.A., Heavy quarkonium production close to neutral gauge E_6 bosons in e^+e^- annihilation, 15:33435 (R;XA)
Pankuch, P.J., *See* Corley, J.P., 15:32911
Panos, C.P., *See* Grypeos, M.E., 15:33568
Pantaloni, J., Study of a liquid-vapour contact evaporator, 15:32868 (R;FR;In French)
Paoloni, F.J., *See* Brown, I.G., 15:33353
Papadopoulos, D., *See* Demaret, J., 15:33521
Papp, G., *See* Holme, A.K., 15:33446
Pardo, R.C., Operating experience with the Argonne PIIECR ion source system, 15:32928 (J;US)
Parhi, N., Oscillatory and nonoscillatory behaviour of solutions of an equation alternately of retarded and advanced type, 15:33684 (R;XA)
Paris, P.J., Controlled thermonuclear fusion: research on magnetic fusion: Experimental hall and remotely operated manipulators. Concept of a reactor, and his environmental impact, 15:33821 (R;CH;In French)
Parise, J.B., *See* Toby, B.H., 15:32630
Park, B., Comments on "Neutron-proton mass difference in the chiral solitonic bag model", 15:33584 (J;US)
Delay of explosive vaporization in pulsed laser-heated droplets, 15:33112 (J;US)
Park, J.T., *See* Coffer, J.L., 15:32814
Park, J.Y., *See* Shack, W.J., 15:32552
Parke, S., *See* Mangano, M., 15:33453
Parker, G.A., *See* Archer, B.J., 15:33369
Parker, G.D., *See* Veselka, T.D., 15:32470
Parker, J.C., *See* Bai, G.R., 15:32607
See Chang, H.L.M., 15:32606
Parker, J.L., *See* Sampson, T.E., 15:32258
Parker, R.H., Camborne geothermal energy project 2C-5. Final report Phase 2C: October 1986 - September 1988, 15:32296 (R;GB)
Parkins, D.M., Radiation induced amorphization in $YBa_2Cu_3O_7$ and $GdBa_2Cu_3O_7$ superconductors, 15:32896 (BA;US)
Parks, C., *See* Renier, J.P., 15:32333
Parmely, C.R., *See* Schettler, P.D., 15:32171
Parsons, J., *See* Beall, C., 15:32162
Pasternak, M.P., *See* Sterer, E., 15:33014
Pato, M.P., SAM revisited: absorptive uniform semiclassical approximation and application to heavy-ion elastic scattering, 15:33570 (R;BR)
Patrushev, Yu.N., *See* Fridzon, M.B., 15:33002
Patt, B.E., Gabor zone plate apertures for imaging with the mercuric iodide gamma ray camera, 15:32973 (R;US)
Patterson, G., *See* Kuykendal, W.B., 15:33096
Patterson, S.R., DOE requirements for the next generation controller, 15:33038 (R;US)
Patton, J.B., *See* Lawler, J.S., 15:32429
Patton, J.T., Absorption properties of carbon dioxide enhanced-oil-recovery additives. Final Technical report, 12 May 1987-31 August 1989, 15:32133 (R;US)
Paul, E.S., *See* Piel, W.F. Jr., 15:33548
Paulikas, A.P., *See* Shaked, H., 15:32688
Pavlo, P., Computer simulation of the interaction of LH waves with thermonuclear alpha particles, 15:33754 (RA;CS)
See Petrzilka, V.A., 15:33759
Pawlewicz, W.T., *See* McCarthy, J.M., 15:32726
Payne, J., Subduction zone tectonic studies to develop concepts for the occurrence of sediment subduction (Phase 2): Volume 1: Final report, 15:32168 (R;US)
Subduction zone tectonic studies to develop concepts for the occurrence of sediment subduction (Phase 2): Volume 2: Final report, 15:32169 (R;US)
Subduction zone tectonic studies to develop concepts for the occurrence of sediment subduction (Phase 2): Volume 3: Final report, 15:32170 (R;US)
Pearson, F.J. Jr., Chemistry of waters in the Boettstein, Weiach, Riniken, Schafisheim, Kaisten and Leuggern boreholes: a hydrochemically consistent data set, 15:33266 (R;CH)
Peden, C.H.F., *See* Rogers, J.W., 15:32639
Peden, C.H.F., Rogers, J, Kinetic and x-ray photoelectron spectroscopic studies of the thermal nitridation of Si (100), 15:32800 (BA;US)
Pederson, L.R., *See* McGrail, B.P., 15:33279
Pedit, J.A., *See* Miller, C.T., 15:33169
Peercy, P.S., *See* Stiffler, S.R., 15:32752
Peggs, S., *See* Barr, E., 15:32916
Pei, S., Structural phase diagram of the $Ba_{1-x}K_xBiO_3$ system, 15:32687 (J;US)
See Dabrowski, B., 15:32619
Pei-qi, L., *See* JANkowiak, R., 15:33197
Pekshev, P.Yu., *See* Lyagushkin, V.P., 15:33627
Pellin, M.J., *See* Arlinghaus, H.F., 15:32748
Pellissier, M., *See* Spindler, B., 15:32423, 15:32424
Peng, J.L., Superconductivity and magnetic scattering in the $Nd_{2-x}Ce_xCuO_{4-gd}$, 15:32618 (BA;US)
See Lynn, J.W., 15:32680
Peng, W., *See* Dabrowski, B., 15:32625
See Kimball, C.W., 15:32626
Peng, Y., *See* Haymaker, R.W., 15:33523
Pennell, W.E., Heavy-section steel technology program - Fracture issues, 15:32405 (RA;US)
Pennington, D.M., *See* Hellwarth, R.W., 15:32765
Pennock, S., *See* Barth, M., 15:32887
Pennycook, S.J., Atomic scale imaging of the structure and chemistry of semiconductor interfaces, 15:32698 (R;US)
Structural and chemical imaging of superconductors and semiconductors by high-resolution STEM, 15:32719 (BA;US)
See El-Ghor, M.K., 15:32746
See Eres, D., 15:32739
See Zuhr, R.A., 15:32627
Pepper, S., *See* Costantino, C.J., 15:32394
Peretrukhin, V.P., *See* David, F., 15:32833
Peretrukin, V.F., *See* David, F., 15:32787

Perez, R.B., *See* deSaussure, G., 15:33560
Perez-Mendez, V., *See* Cho, Gyuseong, 15:32977
Perkowitz, S., *See* Williams, G.P., 15:32691
Perneczky, L., *See* Szabados, L., 15:32375
Perng, C., *See* Koseff, J.R., 15:33391
Peter, R.A., Engineering aspects of long pulse, CO_2 lasers employing plasma discharge electrodes, 15:32893 (BA;US)
Peters, J.E., *See* Barnhart, J.S., 15:32862
Peters, N., Environmental review of Southern Maryland Electric Cooperative's proposed combustion-turbine generating facility at Chalk Point, 15:32317 (R;US)
Peters, T]., Exploratory borehole Leuggern: geology: Appendix volume, 15:33263 (R;CH;In German)
Exploratory borehole Leuggern: geology: Text volume, 15:33264 (R;CH;In German)
Petersen, R.L., Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 1, Detailed report, 15:32137 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 2, Figures and tables for the detailed report, 15:32138 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 3, Appendices A–G, 15:32139 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 4, Appendix H, Concentration contours in the Y-Z plane, 15:32140 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A review of previous related work: Volume 1, Detailed report, 15:32141 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A review of previous related work: Volume 2, Tables and figures for the detailed report, and Appendices A and B, 15:32142 (R;US)
Peterson, D.T., *See* Anderson, M.S., 15:32593
Peterson, J.M., *See* Haroun, L.A., 15:32202
Peterson, M.R., *See* Eggert, K.G., 15:32101
Pethica, J.B., Mechanical properties of nanometre volumes of material: Use of the elastic response of small area indentations: Stresses and mechanical properties, 15:32559 (BA;US)
Petravich, G., *See* Hildebrandt, D., 15:33783
See Kalvin, S., 15:33755
Petrzilka, V.A., On the application of the nonlinear reflection coefficient theory to some lower hybrid experimental results on PLT tokamak, 15:33759 (RA;CS)
Pettersson, S., Theoretical considerations on the hot-wire method applied to solids under pressure, 15:32990 (J;US)
Petti, D.A., *See* Hobbins, R.R., 15:32345
Pettifor, D.G., *See* Liu, C.T., 15:32562
See Nicholson, D.M., 15:32564
Petty, C., *See* Norton, M., 15:32885
See Pu, Y.K., 15:32954
Petukhov, A.B., *See* Fridzon, M.B., 15:33002
Pfeifer, M., *See* Krejci, A., 15:33749
Pferdehirt, W., Economic impact study of landfill regulations (R88-7). Final report, 15:33165 (R;US)
Phelps, P.V., Comparison of age-related changes in in vivo and in vitro measures of testicular steroidogenesis after acute cadmium exposure in the sprague-dawley rat, 15:33249 (R;US)
Phillips, C.H., *See* Griffiths, J.F., 15:32837
Phillips, N.E., Effect of Cu^{2+} magnetic moments on the superconductivity of $YBa_2Cu_3O_7$: The origin of the "linear term" in the specific heat; The volume fraction of superconductivity, 15:32613 (R;US)
Phillips, P.E., *See* Huang, L.K., 15:33799
Phillips, R.J.N., *See* Barger, V., 15:33452
Philipot, S.R., Calculation of free energy from the internal-energy distribution function, 15:33615 (R;US)
Piacitelli, G.M., Diesels in the occupational environment: An environmental perspective, 15:33073 (R;US)
Pick, M.A., High heat flux components: Workshop held at JET on 25/26 September 1989, 15:33773 (RA;GB)
Pickens, J.F., *See* Belanger, D.W., 15:33268, 15:33269
Picraux, S.T., *See* Horn, K.M., 15:32584
Piel, H., *See* Portis, A.M., 15:32664
Piel, W.F. Jr., High-spin structure of N=51 ^{96}Rh and ^{97}Pd: A shell-model study, 15:33548 (J;US)
Piepenbring, R., Anharmonicities of vibrational motion in even-even deformed nuclei, 15:33575 (R;FR)
Pieper, S.C., Ground state of ^{16}O, 15:33583 (J;US)
Pierce, D.A., The shape of the cancer mortality dose-response curve for atomic bomb survivors, 15:33229 (R;JP)
Pierson, R.K., *See* Larson, J.A., 15:32335
Pilfl, V., Time resolved diagnostics of hot plasma radiation by Si surface barrier detectors, 15:33747 (RA;CS)
Pigeaud, A., Effects of coal-derived trace species on the performance of molten carbonate fuel cells: Technical progress report No. 15 (annual progress and interim project evaluation), August 22, 1988–August 21, 1990, 15:32476 (R;US)
Pike, R., Nuclear Weapon Personnel-Reliability Program. Directive, 15:33019 (R;US)
Pile, P.H., *See* Chrien, R.E., 15:33533
Pillon, S., Investigation on U - O - Na, Pu - O - Na and U,Pu - O - Na phase diagrams, 15:32603 (R;FR;In French)
Pin, F.G., Multi-criteria position and configuration optimization for redundant platform/manipulator systems, 15:32847 (R;US)
Optimal positioning of redundant manipulator-platform systems for maximum task efficiency, 15:32846 (R;US)
Pina, L., The potential of CCDs for hot plasma diagnostics, 15:33748 (RA;CS)
Pindzola, M.S., Correlation enhancement of the electron-impact ionization cross section for excited-state Ne-like ions, 15:33370 (J;US)
Strong-field laser ionization of alkali atoms using two-dimensional cylindrical and three-dimensional Cartesian time-dependent Hartree–Fock theory, 15:33358 (J;US)
See Griffin, D.C., 15:33328
Pinnick, R.G., *See* Park, B., 15:33112
Pino, G., *See* Orsini, G., 15:32398
Pitcher, E.J., *See* Smith, H.V. Jr., 15:33792
Pitts, J.H., *See* Tobin, M.T., 15:33823
Pitz, W.J., *See* Burcat, A., 15:32167
See Cowart, J.S., 15:32519
See Griffiths, J.F., 15:32837
See Wilk, R.D., 15:32520, 15:32789
Placet, M., Emissions involved in acidic deposition processes: Methodology and results, 15:33048 (R;US)
Planeta, R., Nucleon exchange properties of the E/A=8.5 MeV ^{74}Ge+^{165}Ho reaction, 15:33549 (J;US)
See Kwiatkowski, K., 15:33550
Plummer, E.W., *See* Kang, M.H., 15:32597
Plunkett, J.E., *See* Poku, J.A., 15:32049
Pochodzalla, J., *See* Eckert, E.M., 15:33559
Podest, M., Main tasks of the Nuclear Research Institute in the period till the year 2000: Preliminary version, 15:33835 (R;CS;In Czech)
Poettken, H.-G., *See* Aichinger, H.M., 15:32501
Poff, K.L., *See* Konjevic, R., 15:33206
Poker, D.B., Calculation of ion channeling directions in low symmetry optical materials, 15:32643 (BA;US)
See Xia, W., 15:32760
Poku, J.A., Assessment of membrane gas separation applications to METC [Morgantown Energy Technology Center] supported techniques: Final report, 15:32049 (R;US)
Polk, D.E., *See* McCandlish, L.E., 15:32617
Pollacco, E.C., *See* Gomez del Campo, J., 15:33537
Pollock, M.D., On the dimensional reduction of a gravitational theory containing higher-derivative terms, 15:33700 (R;XA)
Polnarev, A.G., *See* Braginsky, V.B., 15:33673
Pomraning, G.C., *See* Malvagi, F., 15:33393
Pondrom, L., *See* James, C., 15:33414
Ponevac, J., Utilization of waste heat in sintering process, 15:32500 (R;GB)
Pontuschka, W.M., *See* Isotani, S., 15:33335
Pope, L.E., *See* Folistaedt, D.M., 15:32573
Pope, M., Electrolysis at an anthracene crystal/aqueous NO_3^- solution interface: The role of crystal defects, 15:32813 (J;US)
Pope, S.B., *See* Cant, R.S., 15:32861

Popov, V.S., 1/n-expansion and scaling for the Stark effect in Rydberg atoms, 15:33334 (R;XA)
Strong-field Stark effect: Perturbation theory and 1/n-expansion, 15:33333 (R;XA)
Por, G., *See* Lipcsei, S., 15:32340
Porter, L.E., Recommended Bethe–Bloch stopping power parameters for Kapton and Havar, 15:33598 (J;US)
Porter, W.D., Phase and microstructure of Fe modified Al_3Ti, 15:32585 (BA;US)
See George, E.P., 15:32577
See Schneibel, J.H., 15:32576
Portis, A.M., Microwave surface impedance of granular superconductors, 15:32664 (BA;US)
Portnoy, W., *See* Graham, G., 15:32891
Poukey, J.W., *See* Harper-Slaboszewicz, V.J., 15:32918
Poulter, J.F., *See* Chong, Y.P., 15:32946
Poupeau, G., *See* Rossi, A.M., 15:33612
Powell, G.L., *See* Hutchinson, D.P., 15:33723
Powell, R.M., Interlaboratory methods comparison for the total organic carbon analysis of aquifer materials, 15:33170 (R;US)
Powell, R.O., *See* Edwards, L.K., 15:32491
Power, G., *See* Bell, P.M., 15:32979
Prado, N., *See* Nazareth, R.A.M.S., 15:33564
Prager, S.C., *See* Dexter, R.N., 15:33810
Prasad, A.K., *See* Koseff, J.R., 15:33391
Predazzi, E., *See* Bediaga, I., 15:33428
Preece, D.S., Rock motion simulation and prediction of porosity distribution for a two-void-level retort, 15:32184 (R;US)
Premuzic, E.T., *See* Manowitz, B., 15:32164
Prentice, A.J.R., Neptune's Triton: A moon rich in dry ice and carbon, 15:33310 (R;US)
Price, L., *See* Abachi, S., 15:33420
Price, R.L., Management of hazardous and environmentally sensitive materials. Final report, 15:32444 (R;US)
Prince, R., *See* George, G.N., 15:32285
Prior, M., *See* Barrett, M., 15:32329
Priotton, J.J., *See* Floch, H.G., 15:32532
Proctor, I.D., The LLNL [Lawrence Livermore National Laboratory] ion source: Past, present and future, 15:32944 (R;US)
See Davis, J.C., 15:32941
See Southon, J.R., 15:32942
See Vogel, J.S., 15:33196
Prono, D.S., High average-power induction linacs, 15:32912 (BA;US)
Protheroe, R.J., *See* Halzen, F., 15:33317
Proudfoot, J., Radiation tolerance implications for the mechanical design of a scintillator calorimeter for the SSC, 15:32967 (R;US)
Pruneda, C., Development of a high-tensile-strain plastic-bonded TATB explosive, 15:33030 (R;US)
Pu, Y.K., Electron cyclotron resonance ion source frequency scaling and radial confinement in a quadrupole magnetic field, 15:32954 (J;US)
Puppin, E., *See* Braicovich, L., 15:32769
Pursch, H., *See* Hildebrandt, D., 15:33753
Putterman, S., *See* Larraza, A., 15:33395

Q

Qiao, C.Y.P., *See* Lundin, C.D., 15:32045
Qiu, W.W., *See* Swisher, J.H., 15:32543
Quentin, P., Approximate energy correction for particle number symmetry breaking in constrained Hartree-Fock plus BCS calculations, 15:33586 (J;US)
Quinn, B.P., *See* Reden, K.F. von, 15:33417
Quiros, M., *See* del Aguila, F., 15:33454
Qureshi, S., *See* Cho, Gyuseong, 15:32977

R

Rabalais, J.W., *See* Robertson, J.L., 15:32672, 15:32718
Rabbani, S.R., *See* Isotani, S., 15:33335
Rabe, H.J., *See* Milkau, U., 15:33552
Rabin, B.H., *See* Korth, G.E., 15:32544
Rabinovitch, B.S., *See* Tardy, D.C., 15:32839
Rabinski, M., Modelling the edge plasma dynamics in a tokamak using Grad's approximation, 15:33757 (RA;CS;In Russian)
Radeka, V., *See* Stevens, A., 15:32966
Rader, D.J., Aerosol Dynamics Laboratory, 15:33000 (R;US)
Radousky, H.B., *See* Folkerts, T.J., 15:32651
See Peng, J.L., 15:32618
Raffray, Y., *See* Sebille, F., 15:33577
Ragaini, R.C., Treatment and destruction of hazardous chemical wastes, 15:33106 (R;US)
Raghavan, S., *See* Santanam, L., 15:32239
Rai, R.S., $\delta^2 - Y_2Si_2O_7$ structure confirmed by processing and simulaton of atomic-resolution images, 15:32636 (BA;US)
Rajala, S.A., Evaluation of the wake effects on plume dispersion using video image analysis, 15:33090 (R;US)
Rajan, S., Beneficiated fine-particle coal as a source of energy in small-scale applications, 15:32115 (RA;US)
Rajpoot, S., Completely ununified standard model, 15:33469 (J;US)
See He, X., 15:33466
Ramalingam, S.C., Transient group combustion: Steady state simulation and transient results, 15:32119 (BA;US)
Ramanathan, M., *See* Alp, E.E., 15:33327
Ramasamy, S., *See* Eastman, J.A., 15:32622
Rameswamy, R., *See* Cerdeira, H.A., 15:33672, 15:33674
Ramelka, R., *See* James, C., 15:33414
Ramey, H.J. Jr., *See* Mishra, S., 15:32134
Ramirez, J.J., *See* Corley, J.P., 15:32911
Ramond, P., *See* Minahan, J.A., 15:33519
Ramsey, W.G., WIPP/SRL [Waste Isolation Pilot Plant/Savannah River Laboratory] in-situ tests: Compositional correlations of MIIT [Materials Interface Interactions Test] waste glasses, 15:32213 (R;US)
Randjbar-Daemi, S., Anyons and Chern-Simons theory on compact spaces of finite genus, 15:33497 (R;XA)
Introductory lectures on conformal field theory and strings, 15:33500 (R;XA)
Ranfone, S., *See* Davidson, A., 15:33458
Rangarajan, G., *See* Neri, F., 15:33717
Ransome, R.D., Charged-particle multiplicities following pion absorption on ^{6}Li, 15:33532 (J;US)
Rao, D., *See* Oseroff, S.B., 15:32677
Rao, M.N., *See* Akovali, Y.A., 15:33551
Rapoport, E., *See* Robertson, J.L., 15:32672
Rashid, Y.R., *See* Dameron, R.A., 15:32399
Rasmuson, D.M., *See* Russell, K.D., 15:32362
Rasmussen, D.R., *See* Carter, C.B., 15:32634
Ratcliff, B., *See* Aston, D., 15:33410
Ratcliff, M.A., *See* Petersen, R.L., 15:32137, 15:32138, 15:32139, 15:32140, 15:32141, 15:32142
Ratzel, A.C., Aerosol cloud generation experiments, 15:33026 (R;US)
Rau, N.S., Reliability differentiated pricing of electricity service, 15:32436 (R;US)
Raus, J., Model of collisional and radiative processes in REBEX plasma, 15:33744 (RA;CS)
Rausch Traubenberg, M. d, Beyond spinors, 15:33666 (R;FR)
Ravenscroft, D., *See* Prono, D.S., 15:32912
Ravex, A., Adsorption in cryogenics, 15:32841 (R;FR;In French)
Ravimohan, C., *See* Balasubramanian, K., 15:33383
Ravindra, N.M., Electrical and structural properties of $TiSi_2$ films: Fundamentals, structure, and devices, 15:32737 (BA;US)
Ray, L., *See* Moshi, M.G., 15:33557
Reader, J., Spectrum and energy levels of six-times-ionized molybdenum (Mo VII), 15:33345 (J;US)
Readey, M.A., *See* Groh, K.R., 15:33260
Reagan, D., *See* Rolfe, J., 15:32947
Rebut, P.-H., The new phase for JET and its objective: Workshop held at JET on 25/26 September 1989, 15:33765 (RA;GB)
See Lallia, P.P., 15:33777
See Watkins, M.L., 15:33766
Reda, D.C., Liquid crystal coatings for surface shear stress visualization in hypersonic flows, 15:32709 (R;US)
Reden, K.F. von, Quasielastic electron scattering and Coulomb sum rule in ^{4}He, 15:33417 (J;US)

Redey, L., Resistivity measurements of halide-salt/MgO separators for thermal cells, 15:32441 (R;US)
Redish, E.F., *See* Elster, C., 15:33589
Redon, N., *See* Quentin, P., 15:33586
Reece, W.J., *See* Gertman, D.I., 15:32416
Reed, R.P., *See* Dudney, C.S., 15:33111
Reethof, G., Acoustic agglomeration of power plant fly ash for environmental and hot gas cleanup: Final report: Revised Version, 15:32311 (R;US)
Reffo, G., Reply to "Absence of parity effects in preequilibrium γ emission", 15:33588 (J;US)
Rehm, K.E., *See* Belkacem, A., 15:33635
Rehn, L.E., *See* Koike, J., 15:32575
See Liu, J.C., 15:32725
See Meng, W.J., 15:32574
See Scheuer, U., 15:32568
Reich, M., *See* Costantino, C.J., 15:32394
Reid, J., Military Liaison Committee to the Department of Energy. Directive, 15:33018 (R;US)
On the detection of the radiation amplitude zero in $e^{\pm}p$ collisions, 15:33467 (J;US)
Reinhardt, F.W., *See* Guidotti, R.A., 15:32440
Reinitzhuber, F., *See* Aichinger, H.M., 15:32501
Reister, D.B., Time optimal trajectories for a two wheeled robot, 15:32853 (R;US)
Relton, M., *See* Kampwirth, R.T., 15:32604
Reiter, D., Burn condition for fusion plasmas, helium particle confinement and exhaust efficiency, 15:33779 (R;DE)
Rej, D.J., *See* Barnes, D.C., 15:33820
Remaud, B., *See* Sebille, F., 15:33577
Remington, B.A., *See* Reffo, G., 15:33588
Ren, J., *See* Whangbo, M.-H., 15:32803
Rendall, H., *See* Jacobsen, T., 15:32124
Renier, J.P., Executive summary: Reactor critical benchmark calculations for burnup credit applications, 15:32333 (R;US)
Renken, R.L., *See* Gottlieb, S., 15:33516
Renner, M.W., *See* Furenlid, L.R., 15:32984
Renner, O., *See* Krejci, A., 15:33749
Reno, J.L., The growth of high quality CdTe on GaAs by molecular beam epitaxy, 15:32754 (J;US)
Repond, J., *See* Abachi, S., 15:33420
Rescia, S., *See* Stevens, A., 15:32966
Rescigno, T.N., Electronic excitation of formaldehyde by low-energy electrons: A theoretical study using the complex Kohn variational method, 15:33379 (J;US)
See Orel, A.E., 15:33373
Rezendes, V.S, The coast guard's cleanup of hazardous waste sites, 15:33126 (R;US)
Rho, M., *See* Park, B., 15:33584
Rhodes, W., Localization versus delocalization of the Davydov soliton: Dispersive collapse under the Schroedinger equation, 15:33201 (J;US)
Ribrag, M., *See* Eckert, E.M., 15:33559
Ricco, A.J., *See* Martin, S.J., 15:33008
Rice, C.K., Initial parametric results using CYCLEZ—An LMTD-specified, Lorenz-Meutzner cycle refrigerator-freezer model, 15:32503 (R;US)
Richard, P., *See* Stockli, M.P., 15:32953
Richards, D.R., *See* Dabrowski, B., 15:32619, 15:32625
See Kimball, C.W., 15:32626
See Pei, S., 15:32687
Richards, M.K., *See* Staley, L.J., 15:33086
Richards, P.L., *See* Verghese, S., 15:32989
Richards, R.K., *See* Hutchinson, D.P., 15:33723
Richardson, J.T., *See* Hogan, R.E. Jr., 15:32290
Richman, J.D., *See* Coffman, D., 15:33423
Richter, M., Electron spectroscopic investigation of atomic 4d giant resonances for Ba, La and lanthanides, 15:33331 (R;DE;In German)
Ricker, C.W., *See* Williams, J.A., 15:32197
Rickman, J.M., *See* Phillpot, S.R., 15:33615
Ricoy, M.A., A new technique for simulating composite material. Task 2: Analytical solutions with generalized impedance boundary conditions (GIBCs). Report, September 1989-February 1990, 15:32705 (R;US)
Rieger, W., *See* Fett, T., 15:32614
Riehl, G., *See* Langbein, K., 15:32955
Riemann, T., *See* Leike, A., 15:33436
Riesen, A.E., *See* Kaufmann, E.N., 15:33656
Rifai, H.S., *See* Newell, C.J., 15:33149
Rife, J.C., *See* Long, J.P., 15:32756
Riffkin, J.A., *See* Clapp, P.C., 15:32563
Riley, D.J., Numerical modeling tools for transient electromagnetic problems, 15:33036 (R;US)
Rimini, A., *See* Ghirardi, G.C., 15:33683
Riodan, E.M., *See* Whitlow, L.W., 15:33433
Ripa, M., Apparatus for measurement of spectral line profile, 15:33746 (RA;CS)
Time development of profile of H_α line in REBEX plasma, 15:33745 (RA;CS)
Ripka, G., Cut-off and effective meson field theory, 15:33431 (R;FR)
Riseman, T.M., *See* Ansaldo, E.J., 15:32633
Ritchie, B.G., *See* Ransome, R.D., 15:33532
Ritchie, R.H., *See* Stein, C., 15:33639
Ritz, C.P., A portable and independent edge fluctuation diagnostic: Technical progress report, September 14, 1989–May 14, 1990, 15:33736 (R;US)
Rivera, W.E., *See* Chong, Y.P., 15:32946
Riviere, J., Comparison between theoretical and experimental results of the 1/6 scale concrete model under internal pressure, 15:32397 (RA;US)
Rizo, P., *See* Ellingson, W.A., 15:32112
Rizy, D.T., *See* Lawler, J.S., 15:32429
Rizzo, H.F., Amorphous and metastable phase formation in systems with positive heats of mixing using high-rate sputter deposition, 15:32569 (BA;US)
Robbins, C.L., Lumen Day: A new concept for daylighting design in commercial buildings. Final report on Phase 1, 15:32486 (R;US)
Roberto, F.F., *See* Ward, T.E., 15:32077
Roberts, D.R., Mode conversion between Alfven wave eigenmodes in axially inhomogeneous two-ion-species plasmas, 15:33796 (J;US)
Roberts, M.L., *See* Davis, J.C., 15:32941
See Proctor, I.D., 15:32944
Robertson, I.M., *See* Bui, T.X., 15:32539
See Smalinskas, K., 15:32541
See Vetrano, J.S., 15:32540
Robertson, J.L., Epitaxial growth of diamond films on Si(111) at room temperature by mass-selected low-energy C^+ beams, 15:32672 (J;US)
On the structure of carbon films deposited on Si(111) by mass-selected low energy C^+ beams, 15:32718 (BA;US)
Robertson, W.M., Light scattering by surface acoustic waves on corrugated metal surfaces, 15:32598 (J;US)
Robilotta, M.R., *See* Ballot, J.L., 15:33573
Robinet, M.J., Volume estimate of radium-contaminated soil in a section of Barrows Field Park, Glen Ridge, New Jersey, November–December 1989, 15:33115 (R;US)
Robinson, S.M., Multicomponent ion-exchange equilibria in chabazite zeolite, 15:32203 (R;US)
Robinson, T. K., *See* Ellingson, W.A., 15:32629
Robischon, S.J., *See* Boyes, J.D., 15:32945
Robiscoe, R.T., Onboard detection of intrinsic Lyα radiation from a neutral particle beam, 15:33041 (R;US)
Rocca, J.J., *See* Wernsman, B., 15:33790
Rock, S., *See* Whitlow, L.W., 15:33433
Rockhold, M.L., *See* Campbell, M.D., 15:32228
Rodgers, M.A.J., Photoinduced charge separation by polymer-bound chromophores: Progress report, September 1986–December 1989, 15:32825 (R;US)
Rodgers, M.S., *See* Schwank, J.R., 15:32986
Rodriguez, D.J., A preliminary evaluation of ADPIC [atmospheric diffusion particle-in-cell] model performance on selected ANATEX [Across North America Tracer Experiment] releases using

observed, analyzed, and dynamically predicted winds, 15:33109 (R;US)
Roe, N.A., Measurement of the two-photon width of the η and η' mesons, 15:33412 (J;US)
Roesener, W.S., *See* Wolford, A.J., 15:32406
Rofer, C.K., *See* Buelow, S.J., 15:32806
Rogers, D.R., *See* Fawley, W.M., 15:32926
Rogers, J.E., *See* Bryant, F.O., 15:33148
Rogers, J.N., A user's guide to the SCABBARD scenario language: Edition 2, 15:33022 (R;US)
Rogers, J.W., Catalytic oxidation of silicon nitride thin films using potassium, 15:32639 (BA;US)
Rogers, R.D., *See* McConnell, J.W. Jr., 15:32217
Rogers, V.C., *See* Nielson, K.K., 15:33140
Roggenthen, D.K., Selection of immobilization technology for TRU [transuranic] waste, 15:32233 (R;US)
Roginski, R.T., *See* Coffer, J.L., 15:32814
Rolfe, J., Long ion chamber systems for the SLC (Stanford linear collider), 15:32947 (BA;US)
Romanelli, F., *See* White, R.B., 15:33793
Roos, R.C., North Slope investigation report, 15:33135 (R;US)
Rose, K., *See* Veselka, T.D., 15:32470
Rose, S., *See* Yennello, S.J., 15:33542
Rosen, M.D., *See* Matthews, D.L., 15:32902
Rosen, R.S., *See* Henshall, G.A., 15:32558
Rosen, S.P., *See* Moe, M.K., 15:33536
Roshko, A., S-N-S behavior of grain boundaries in polycrystalline $La_{1.85}Sr_{0.15}CuO_{4-y}$, 15:32901 (BA;US)
Rosinski, S.T., *See* Chopra, O.K., 15:32321
Rosner, G., *See* Vineyard, M.F., 15:33534
Ross, D.W., Plasma confinement theory and transport simulation: Technical progress report, November 1, 1989–October 31, 1990, 15:33735 (R;US)
Ross, J.H. Jr., NMR studies of $NbSe_3$: Electronic structures, static charge-density-wave measurements, and observations of the moving charge-density wave, 15:32766 (J;US)
Ross, M., *See* Rolfe, J., 15:32947
Rossel, C., *See* Dalichaouch, Y., 15:32761
Rossi, A.M., Radiation-induced paramagnetic species in natural calcite speleothems, 15:33612 (R;BR)
Rossi, L., *See* Pick, M.A., 15:33773
Rosta, L., *See* Cser, L., 15:32353
Rothard, H., *See* Lencinas, S., 15:33597
Rou, S.H., *See* Ameen, M.S., 15:32635
Rouhani, S., Measurement of gravitational acceleration of antimatter, 15:33740 (R;XA)
Rous, P.J., Selection rules in resonance electron scattering from adsorbed molecules, 15:33649 (J;US)
Rowland, M.L., *See* Ward, T.E., 15:32077
Roy, G.D., *See* Doss, E.D., 15:32473
Roy, N., *See* Becker, J.A., 15:33558
Roy, R., *See* Vemuri, G., 15:33382
Royer, G., *See* Sebille, F., 15:33577
Royet, J., *See* Scanlan, R.M., 15:32897
Rubins, M.J., *See* Clapp, P.C., 15:32563
Ruckman, M.W., *See* Jeon, Y., 15:32684
Rudge, M.G., *See* Cernicchiaro, G.R.C., 15:33003
Rudolf, P., *See* Ma, Y., 15:32601
Rueckle, T., Solution of the multigroup transport equations for fuel element assemblies according to the first collision procedure, 15:32331 (R;DE;In German)
Rueter, K., Control loop and unit operational realtime modeling on a Distributed Control System, 15:32242 (R;US)
Ruggiero, S.T., Single-electron charging effects: Technical progress report, 15:33618 (R;US)
Ruland, R., *See* Bell, B., 15:32910
Rumack, D.T., *See* Nelsen, S.F., 15:32823
Rummens, H.E.C., *See* Sakai, Takaaki, 15:32869
Rush, J.J., *See* Udovic, T.J., 15:32682
Rusnak, B., *See* Cooke, D.W., 15:32900
Russell, B.F., *See* Knutson, C.F., 15:32190
Russell, K.D., Living PRAs [probabilistic risk analysis] made easier with IRRAS [Integrated Reliability and Risk Analysis System], 15:32362 (R;US)
Russell, W.J., *See* Kato, Kazuo, 15:33604
Ruther, W.E., *See* Shack, W.J., 15:32552
Rutkowski, H., *See* Humphries, S. Jr., 15:33801
Rutkowski, H.L., Multiple arc ion sources for heavy ion fusion, 15:33833 (J;US)
Rutten, J.J.M.M., Semantic correctness for a parallel object-oriented language, 15:33850 (R;NL)
Ryan, R.E., *See* Arnett, K., 15:33380
Ryan, R.R., *See* Dickinson, J.T., 15:33791
Ryutova, M.P., Nonlinear effects in a plasma with structured magnetic fields, 15:33758 (RA;CS)

S

Saatdjian, E., Contribution to the study of complex physical phenomena in gas-solid reactors for coal hydro-pyrolysis, 15:32069 (R;FR;In French)
Sachs, R.G., *See* Booth, M.J., 15:33456
Sachtjen, S.A., *See* Verghese, S., 15:32989
Sachwitz, M., *See* Leike, A., 15:33436
Sadeghi, H.R., *See* Long, J.P., 15:32756
Sadoulet, B., *See* Wang, N., 15:32595
Saenger, W., *See* Hingerty, B., 15:33200
Safyullin, V.A., *See* Lyagushkin, V.P., 15:33627
Sagan, D., *See* Meller, R.E., 15:32962
Sahira, Kensho, *See* Watanabe, Katsutoshi, 15:32546
Saint-Laurent, F., *See* Gomez del Campo, J., 15:33537
Saito, H., Experimental study for structural behavior of reinforced concrete containment vessel beyond design pressure, 15:32390 (RA;US)
Saito, Hiroaki, *See* Uchida, Masaaki, 15:32320
Saitoh, Teiichiro, *See* Watanabe, Katsutoshi, 15:32546
Saitovitch, E.B., Dynamical information for Fe doped $YBa_2Cu_3O_7$ superconducting oxides obtained from high temperature Moessbauer studies, 15:32602 (R;BR)
Sakaguchi, Kiyoshi, Calculation of positron spectra from heavy-ion collisions and study of the line structure, 15:33329 (R;DE;In German)
Sakai, K., *See* Takeuchi, S., 15:33780
Sakai, Mitsuo, Mass systematics of hypothetical neutral objects in heavy-ion collisions and in e^+ heavy-ion interactions, 15:33336 (R;JP)
Sakai, Takaaki, FIDAS: a three-fluid subchannel code for dryout prediction in rod bundles, 15:32869 (R;JP)
Sakai, Y., Soliton-collision interferometer for the quantum nondemolition measurement of photon number: numerical results, 15:32996 (J;US)
Sakamoto, K., *See* Fujiwara, I., 15:33447
Sakamoto, R., *See* Kouno, S., 15:32315
Salabura, P., Correlated positron-electron emission in heavy-ion collisions at the Coulomb barrier, 15:33330 (R;DE)
Salam, A., *See* Randjbar-Daemi, S., 15:33497
Salat, A., Is the temperature gradient or the derivative of the density gradient responsible for drift solitons?, 15:33741 (R;DE)
Sales, B.C., *See* Boatner, L.A., 15:32246
Salim, J.M., *See* Novello, M., 15:33284
Salisbury, W., *See* Shih, I., 15:32997
Salito, S.A., Measurement of the ion temperature in the tokamak TCA by collective Thomson diffusion in the far infrared, 15:33784 (R;CH;In French)
Salmeron, M., *See* Vandentop, G.J., 15:32770
Saltmarsh, C., *See* Baggett, M.J., 15:32931
See Barr, E., 15:32916
Salzman, G.C., Expert systems for flow cytometry data analysis: A preliminary report, 15:33214 (R;US)
Samanta, B.C., *See* Dey, J., 15:33569
Sambamurti, A., *A* dependence of highly inelastic *p*-nucleus collisions, 15:33418 (J;US)
Saml, S., Electroosmotically enhanced dewatering/deliquoring of fine particle coal, 15:32039 (RA;US)
Sammataro, R.F., Containment long-term operational integrity–a 1988 status report, 15:32377 (RA;US)

Sampson, T.E., Applications of gamma-ray spectrometry in the quantitative nondestructive assay of special nuclear materials, 15:32258 (R;US)
Samuel, M.A., *See* Reid, J., 15:33467
Samuelson, M.R., *See* Svensmark, H., 15:33719
Sand, J.R., *See* Fischer, S.K., 15:32701
See Rice, C.K., 15:32503
Sandage, A., The age of the galactic disk, 15:33299 (R;US)
Sander, L.M., *See* Yan, H., 15:33638
Sanders, D.E., *See* Evans, J.W., 15:33650
Sanders, L., *See* Mole, M.L., 15:33247
Sandusky, T.E., *See* Ludwig, H.R., 15:33240
Sanford, N.M., *See* Burnham, A.K., 15:32529
Sanford, T.W.L., *See* Beutler, D.E., 15:32937
Sann, H., *See* Milkau, U., 15:33552
Santanam, L., Modeling of Zircaloy cladding degradation under repository conditions, 15:32239 (R;US)
Sapirstein, J., *See* Blundell, S.A., 15:33374
Sarkar, V., POSC: A Partitioning and Optimizing SISAL Compiler: Revision 1, 15:33854 (R;US)
Sarzynski, D., *See* Wagner, A.F., 15:32840
Sasaki, J., Ion spectra of the metal vapor vacuum arc ion source with compound and alloy cathodes, 15:33354 (J;US)
Sasaki, Misao, Proceedings of workshop on dark matter and the structure of the universe, 15:33315 (R;JP)
Sato, Takahiro, Kaon rare decays, 15:33403 (RA;JP)
Sato, Tetsuya, *See* Horiuchi, Ritoku, 15:33738
Sattison, M.B., *See* Russell, K.D., 15:32362
Sauer, S., *See* Nehls, P., 15:33220
Sault, L.P., *See* Fleming, B.A., 15:32058
Saultz, R.J., *See* Gammage, R.B., 15:33118
Savoy, C.A., Jordan algebras and flat potentials at one loop, 15:33667 (R;FR)
Sawada, Shozo, *See* Kato, Kazuo, 15:33604
Sayer, R.O., *See* Beene, J.R., 15:33554
Sayer, R.W., *See* Alton, G.D., 15:33640
Sborchia, C., *See* Last, J.R., 15:33771
Scalettar, R.T, Magnetic and pairing correlations in a three band Hubbard model, 15:32646 (BA;US)
Scanlan, R.M., Fabrication of Rutherford-type superconducting cables for construction of dipole magnets, 15:32897 (BA;US)
Schaefer, D.W., Polymers, fractals, and ceramic materials, 15:32671 (J;US)
Schaefer, R.B., *See* Peter, R.A., 15:32893
Schaefer, R.W., Critical experiment tests of bowing and expansion reactivity calculations for liquid-metal-cooled fast reactors, 15:32428 (J;US)
Schaich, W.L., *See* Zhang, J., 15:33651
Schall, J.D., *See* Eggert, K.G., 15:32101
Schart, L.L., *See* Haver, J.F., 15:32432
Schatz, K.W., Effectiveness of water spray mitigation systems for accidental releases of hydrogen fluoride: Volume 6, Appendix H, Selected still photographs, 15:33056 (R;US)
Schatzinger, R.A., *See* Sharma, B., 15:32127
Scheeline, A., Spherical pinch discharges for elemental analysis, 15:32790 (BA;US)
Scheikoph, G.L., *See* Weber, G.F., 15:32310
Schenker, F., *See* Ammann, M., 15:33276
Schettler, P.D., Physicochemical properties of methane storage and transport in Devonian shale. Annual technical report, June 1988-May 1989, 15:32171 (R;US)
Scheuer, U., Ion-beam mixing in amorphous and crystalline Fe-Ti, 15:32568 (BA;US)
Schidlovsky, G., *See* Dezaro, D.A., 15:32163
Schildbach, M.A., Nanometer-scale pulsed laser modification of the basal plane of graphite observed with STM [scanning tunneling microscopy], 15:32716 (R;US)
Schirber, J.E., *See* Ansaldo, E.J., 15:32633
See Hundley, M.F., 15:32683
Schlachter, A.S., *See* Smith, H.V. Jr., 15:33792
Schlesiner, T.E., *See* James, R.B., 15:32632
Schlinger, C.M., *See* Blackett, R.E., 15:32295
Schlitt, L., *See* Curry, R.D., 15:33827
Schlobohm, S.L., *See* Bickes, R.W. Jr., 15:33025
Schlottmann, P., One-dimensional narrow-band model for heavy fermions and resonating valence bonds, 15:33659 (J;US)
Schlueter, F.H., *See* Bachmann, P., 15:32393
Schmidt, B., Annealing studies of B2FeAl, 15:32586 (BA;US)
Schmidt, C.E., *See* White, C.M., 15:32107
Schmidt, M., *See* Schneefuss, J., 15:32225
Schneefuss, J., Grimsel Test Site: heat test, final report, 15:32225 (R;CH;In German)
Schnelbel, J.H., Microstructure and mechanical properties of Ll_2-structure alloys based on Al_3Zr, 15:32576 (BA;US)
Schneider, D., *See* Belkacem, A., 15:33635
Schobert, H.H., Inhibition of retrogressive reactions in coal/petroleum co-processing: Quarterly technical progress report, December 1, 1989–February 28, 1990, 15:32053 (R;US)
Schoengold, C.R., Radiological effluents released from announced US continental tests, 1961 through 1988, 15:33035 (R;US)
Scholtis, A., *See* Pearson, F.J. Jr., 15:33266
Schoonover, J., *See* Belhadj, M., 15:33202
Schrama, J.T.A., Passive use of solar energy in the public housing of Capelle aan den IJssel, Netherlands: Evaluation and final report, 15:32291 (R;NL;In Dutch)
Schreiber, G., *See* Furlong, M., 15:32060
Schroeder, M.H., *See* Kracht, G., 15:32471
Schuck, P., *See* Sebille, F., 15:33577
Schuettler, H., *See* Benedek, R., 15:33657
See Chen, C., 15:32681
Schuhmann, R., *See* Buescher, M., 15:33545
Schuler, A.K., Wind tunnel tests on the evaluation of interferences due to buildings on the propagation of radioactive materials after release from nuclear facilities. Report and annex, 15:33046 (R;DE;In German)
Schuler, P., *See* Keusen, H.R., 15:33267
Schull, W.J., *See* Otake, Masanori, 15:33228
Schuller, I.K., *See* Robertson, W.M., 15:32598
Schultz, S., *See* Oseroff, S.B., 15:32677
Schumacher, B., *See* Southon, J.R., 15:32942
Schumm, S.A., *See* Gregory, D.I., 15:32099
Schutz, Y., *See* Beene, J.R., 15:33554
Schuurman, J.J., *See* Curvers, A., 15:32304
Schwaar, R.H., *See* Wilson, R.B. Jr., 15:32050
Schwab, A., *See* Mayer, R., 15:32982
Schwalbe, L.A., *See* Windisch, D.E., 15:32732
Schwank, J.R., Total-dose degradation of thin film ferroelectric capacitors, 15:32986 (R;US)
See Shaneyfelt, M.R., 15:32882
See Winokur, P.S., 15:32881
Schwartz, R.W., *See* Tuttle, B.A., 15:32712
Schwegler, J., *See* Cooke, D.W., 15:32693
Scofield, J.H., *See* Fleetwood, D.M., 15:32749
Scorzelli, R.B., *See* Saitovitch, E.B., 15:32602
Scott, J.C., Computerized data-base system for land-use and land-cover data collected at ground-water sampling sites in the pilot National Water-Quality Assessment Program. Water-Resources Investigation, 15:33152 (R;US)
Scott, T.C., *See* Basaran, O.A., 15:32872
Scott, W., *See* Wood, L., 15:33044
Scribner, K., *See* Holtz, E. von, 15:33029
See von Holtz, E., 15:33032
Seaman, C.L., *See* Dalichaouch, Y., 15:32670
See Maple, M.B., 15:32641
See Weir, S.T., 15:32899
Sears, R., *See* Curry, R.D., 15:33827
Sebille, F., Nuclear dynamics with the finite range Gogny force, 15:33577 (R;FR)
Seeger, M., *See* Aichinger, H.M., 15:32501
Sega, R.M., *See* Windisch, D.E., 15:32732
Segar, P.R., *See* Koval, C.A., 15:32824
Segawa, R., *See* Supkoff, D., 15:32282
Sehl, G., The reaction anti pp → anti ΛΛ 92 MeV above the reaction threshold, 15:33402 (R;DE;In German)
Seidensticker, R.W., *See* Wu, Ting-shu, 15:32842
Seidl, M., *See* Souzis, A.E., 15:33363
Seifert, R., Application of near real time accountancy to nuclear material balance data, 15:32257 (R;DE)

Sekar, R.R., *See* Cole, R.L., 15:32502
Selby, D.L., *See* Cheverton, R.D., 15:32356
Seldner, D., Parallel treatment of simulation particle-in-cell codes on SUPRENUM, 15:33782 (R;DE)
Sen, A., Non-linear σ-models and string theories, 15:33511 (BA;US)
Sen, A.K., *See* Mathey, O., 15:33797
Senda, I., Comment on phenomenology of the almost standard model, 15:33439 (R;XA)
See Lizzi, F., 15:33499
Sengers, J.V., *See* Chen, Z.Y., 15:33396
Senum, G.I., A perfluorocarbon tracer transport and dispersion experiment in the North Sea Ekofisk oil field: Revision, 15:33116 (R;US)
Seo, Y., Urban aerosol transformation and transport modeling. Report for October 1985-October 1988, 15:33091 (R;US)
Seres, Z., *See* Bastrukov, S.I., 15:33341
Sergeev, A.V., *See* Popov, V.S., 15:33333, 15:33334
Serrao, V.A., *See* Franco, M.A.R., 15:32879
Servranckx, R.V., *See* Ford, W.T., 15:32927
Sessler, A.M., *See* Autin, B., 15:32917
Setmire, J.G., Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the Salton Sea Area, California, 1986-87. Water-Resources investigation, 15:33164 (R;US)
Seto, T., *See* Suehiro, M., 15:32072
Sette, F., *See* Ma, Y., 15:32601
Severing, A., Neutron scattering experiments on $YbXCu_4$ and $ErXCu_4$ (X=Au, Pd, and Ag), 15:32591 (J;US)
Sexton, F.W., SEU characterization and design dependence of the SA3300 microprocessor, 15:33853 (R;US)
See Shaneyfelt, M.R., 15:32882
See Winokur, P.S., 15:32881
Seyfarth, H., *See* Meyer, R.A., 15:33547
Shack, W.J., Environmentally assisted cracking in light water reactors, 15:32552 (RA;US)
See Chopra, O.K., 15:32321
Shackelford, S.A., Condensed-phase kinetic deuterium isotope effects in high-energy phenomena: Mechanistic investigations and relationships. Technical report, January 1975-December 1989, 15:33024 (R;US)
Shaffer, R.J., *See* Heuze, F.E., 15:33039
Shah, S., *See* Chaudhuri, J., 15:32570
Shah, V.N., Life assessment procedures for major LWR components, 15:32407 (RA;US)
Shaing, K.C., Neoclassical quasilinear transport theory of fluctuations in toroidal plasmas: Further considerations, 15:33794 (J;US)
Shaked, H., Structural and superconducting properties of oxygen-deficient $NdBa_2Cu_3O_{7-\delta}$, 15:32688 (J;US)
Sham, T.K., *See* Shek, M., 15:32594
Shamsi, A., Study of eastern and western oil shale minerals activity for hydrodesulfurization (HDS) and hydrodenitrogenation (HDN) reactions, 15:32189 (BA;US)
Shaneyfelt, M.R., Field dependence of interface trap buildup in Si-gate MOS devices, 15:32882 (R;US)
See Winokur, P.S., 15:32881
Shao, Jian Dong, *See* Baer, T., 15:32822
Shapiro, S.L., *See* Jernigan, J.G., 15:32938
Shapley, J.R., *See* Coffer, J.L., 15:32814
Shaposhnikov, M.E., *See* Grigoriev, D.Yu., 15:33507
Shara, M.M., Recent progress in understanding the eruptions of classical novae, 15:33300 (R;US)
Sharafeddin, O., *See* Hoffman, D.K., 15:33385
Sharma, B., Critical heterogeneities in a barrier island deposit and their influence on various recovery processes, 15:32127 (J;US)
Sharon, A., A model for a recovery of a badly degraded core, 15:32361 (R;US)
Sharp, C.M., Molecular equilibrium with condensation, 15:33320 (J;US)
Sharp, J.W., *See* Eres, D., 15:32739
Sharp, L.E., *See* Blackwell, B.D., 15:33803
See Howard, J., 15:33728
Shaughnessy, A.T., Long-term benthic monitoring studies in the freshwater portion of the Potomac River: 1983 to 1985, cumulative report. Volume 1. Text, 15:33143 (R;US)
Long-term benthic monitoring studies in the freshwater portion of the Potomac River: 1983 to 1985, cumulative report. Volume 2. Appendices, 15:33144 (R;US)
Shaw, D.T., *See* Kaufmann, E.N., 15:33656
Shaw, H., *See* Santanam, L., 15:32239
Shaw, P.G., Rapid determination of plutonium content on filters and smears using Alpha Liquid Scintillation, 15:32974 (R;US)
Shcherbinin, E.V., *See* Tsinober, A.B., 15:33607
Shea, D.M., *See* Shea, M.F., 15:32915
Shea, M.F., Control system for the Neutron Therapy Facility at Fermilab, 15:32915 (BA;US)
Shek, M., Core-level photoemission from alkali metals on Ru(001), 15:32594 (J;US)
Shekhar, R., *See* Evans, J.W., 15:32504
Shelton, R.N., *See* Folkerts, T.J., 15:32651
See Lynn, J.W., 15:32680
See Peng, J.L., 15:32618
Shen Jianmin, *See* Chang Zhe, 15:33498
See Guo Hanying, 15:33681
Shen, Q., X-ray diffraction study of the Ni(111)5°[1$\bar{1}$0] vicinal surface, 15:32588 (J;US)
Shen, Y., *See* Wreathall, J., 15:32420, 15:32421
Shepard, K.W., Status of superconducting RF cavity development, 15:32951 (BA;US)
Shi, H., *See* Bai, G.R., 15:32607
See Shaked, H., 15:32688
Shi, X.H., *See* Blackwell, B.D., 15:33729
See Hamberger, S.M., 15:33724
Shibuya, S., *See* Tokuda, N., 15:32923
Shiekh, A.Y., *See* Lee, S.C., 15:33293, 15:33695
Shields, H., X-ray preionization technology for high pressure gas discharge lasers, 15:32890 (BA;US)
Shih, I., Measurements of Smith–Purcell radiation, 15:32997 (J;US)
Shih, M.C., *See* Bohanon, T.M., 15:32777
Shilkett, R.C., *See* Ozaki, C.B., 15:32252
Shimazaki, Junya, HTTR plant dynamic simulation using a hybrid computer, 15:32344 (R;JP;In Japanese)
Shimbo, D.T., A comparison of relative permeability from centrifuging versus coreflooding, 15:32129 (R;US)
Shin, S.H., *See* Meroney, R.N., 15:32143
Shindo, Ryuichi, *See* Yamashita, Kiyonobu, 15:32352
Shinohara, Yoshikuni, *See* Shimazaki, Junya, 15:32344
Shiraga, H., *See* Daido, H., 15:32936
Shiraishi, H., Operational characteristics of a metal vapor vacuum arc ion source, 15:33355 (J;US)
See Brown, I.G., 15:33831
Shiraishi, K., *See* Nakamura, A., 15:33477
Shirane, G., *See* Tranquada, J.M, 15:32659
Sholeen, C.M., Radiological oversight and certification report for the Lansdowne property, 105-107 East Stratford Avenue, Lansdowne, Pennsylvania, August 1988–June 1989, 15:33114 (R;US)
Shore, B.W., *See* Kulander, K.C., 15:33352
Shorter, R., National urban-mass-transportation statistics. 1988 Section 15. Annual report. Report for 1 January-31 December 1988, 15:32495 (R;US)
Shoup, M.J. III, *See* Smith, D.L., 15:32903
Shtern, A.G., *See* Tsinober, A.B., 15:33607
Shubat, M.A., *See* Blackett, R.E., 15:32295
Shum, V.T., *See* Morris, D.E., 15:32686
Shuryak, E.V., Physics of the pion liquid, 15:33562 (R;US)
Sieck, L.W., *See* Nelsen, S.F., 15:32823
Siegel, D.I., Evaluating cumulative effects of disturbance on the hydrologic function of bogs, fens, and mires, 15:33174 (R;US)
Siegel, H.J., Using the multistage cube network topology in parallel supercomputers, 15:33856 (J;US)
Siegel, J.S., The importance of clean coal technologies to reduce power plant emissions, 15:32312 (RA;US)
Siegel, R.W., Synthesis, characterization, and properties of nanophase ceramics, 15:32620 (BA;US)
See Eastman, J.A., 15:32622
See Epperson, J.E., 15:32621
See McCandlish, L.E., 15:32617
Siekhaus, W.J., *See* Schildbach, M.A., 15:32716
Sieweke, M.H., *See* Stoker, A.W., 15:33207

Sigmon, T.W., *See* Weiner, K.H., 15:32895
Silver, L., *See* Loveland, W., 15:33555
Sikka, V.K., Melting of iron-aluminide alloys, 15:32044 (R;US)
Silber, R.R., *See* Hodge, C.A., 15:32852
Silber, M., *See* Goldstein, H.F., 15:33392
Sill, C.W., Long-term stability of solid standards for radiochemical analysis, 15:32785 (R;US)
Silliman, M, *See* Spelt, P.F., 15:32843
Silva, E. de P. da, Susceptibility of the Potts model in an hierarchical lattice: renormalisation group approach, 15:33613 (R;BR)
Silva, L.R. da, *See* Mariz, A.M., 15:33611
Silveira, R. da, About rainbow scattering in the presence of absorption, 15:33338 (R;FR)
Similon, P.L., Plasma turbulence, 15:33832 (J;US)
Simms, D.A., *See* Butterfield, C.P., 15:32306
Simonini, R., *See* Watkins, M.L., 15:33766
Simpson, J.P., Experiments on container materials for Swiss high-level waste disposal projects. Part IV, 15:32550 (R;CH)
Simpson, Y.K., *See* Carter, C.B., 15:32634
Singer, I.L., Energy beam treatment for improved adhesion of coatings to surfaces, 15:32697 (P;US)
Singh, A., *See* Antonsen, T.M. Jr., 15:33732, 15:33808, 15:33809
Singh, J.P., *See* Ellingson, W.A., 15:32112
Sinha, A.P.B., *See* Morris, D.E., 15:32686
Sinha, S.K., *See* Pei, S., 15:32687
See Vaknin, D., 15:32676
Siriwardane, H.J., Ground movements associated with gas hydrate production in geologic media: Final report, 15:32172 (R;US)
Sirois, E., *See* Bui, T.X., 15:32539
Sithole, I., *See* Babcock, G.T., 15:32286
Sivill, R.L., Advanced Liquid Metal Reactor site selection criteria report, 15:32348 (R;US)
Reference site selection report for the advanced liquid metal reactor at the Idaho National Engineering Laboratory, 15:32347 (R;US)
Sjoreen, T.P., Damage formation in semiconductors during MeV ion implantation, 15:32740 (BA;US)
Skanthakumar, S., *See* Lynn, J.W., 15:32680
Skocypec, R.D., Modeling laser ignition of explosives and pyrotechnics: Effects and characterization of radiative transfer, 15:33028 (R;US)
See Hogan, R.E. Jr., 15:32290
Slagle, I.R., *See* Wagner, A.F., 15:32840
Slaney, J.K., Parallelizing the closure computation in automated deduction, 15:33840 (R;US)
Sleight, A.W., *See* Toby, B.H., 15:32630
Slichter, C.P., *See* Ross, J.H. Jr., 15:32766
Sloan, G., An algorithm for using a slide-screw tuner as a computer-controlled impedance, 15:32883 (R;US)
Slobodenyuk, V.A., *See* Aliev, T.M., 15:33437
Smaga, J.A., *See* Guidotti, R.A., 15:32440
Smalinskas, K., Role of melting temperature on the properties of displacement cascades, 15:32541 (R;US)
Small, G.J., *See* JANkowiak, R., 15:33197
Smartt, H.B., *See* Carlson, N.M., 15:32848
Smatlak, D., *See* Pu, Y.K., 15:32954
Smit, H., Nature demands stricter limits, 15:32105 (R;NL)
Smith, A.W., *See* Helayel Neto, J.A., 15:33494
See Helayel-Neto, J.A., 15:33472, 15:33473
Smith, B.G., *See* Bruns, D.A., 15:33124
Smith, B.L., *See* Boyes, J.D., 15:32945
Smith, B.R., *See* Stein, C., 15:33639
Smith, C.L., *See* Doggett, N.A., 15:33210
Smith, D.L., Applications of strained layer superlattices, 15:32715 (R;US)
Low cost active–active oscillator utilizing loss feedback control, 15:32903 (J;US)
Smith, D.M., *See* Hietala, S.L., 15:32615
Smith, E.B., Jet fuels potential of liquid by-products from the Great Plains Gasification Project, 15:32048 (R;US)
Smith, G.R., Minerals yearbook, 1988. Tungsten, 15:32456 (R;US)
Smith, G.V., Modification of coal surfaces with methyl radicals, 15:32057 (RA;US)
Smith, H.V. Jr., H^0 temperature and density measurements in a Penning surface-plasma H^- ion source. I., 15:33792 (J;US)
Smith, J.B., Potential Effects of Global Climate Change on the United States. Appendix H. Infrastructure. Report to the Congress, 15:33069 (R;US)
Potential Effects of Global Climate Change on the United States. Appendix B. Sea-level rise. Report to the Congress, 15:33070 (R;US)
Potential Effects of Global Climate Change on the United States. Appendix G. Health. Report to the Congress, 15:33071 (R;US)
Potential Effects of Global Climate Change on the United States. Appendix L. Variability. Report to the Congress, 15:33072 (R;US)
Smith, J.C.W., The design of a 1/10th scale model of the Sizewell B Primary Containment, 15:32392 (RA;US)
Smith, J.G., *See* Sami, S., 15:32039
Smith, J.S., *See* Felder, E., 15:32581
See Lee, H.P., 15:32729
Smith, L., Precision and accuracy assessments for state and local air-monitoring networks, 1988, 15:33080 (R;US)
Smith, P., *See* Kartik, S., 15:33411
See Sambamurti, A., 15:33418
Smith, R.D., Capillary electrophoresis combined with mass spectrometry, 15:33198 (BA;US)
See Tingey, J.M., 15:32815
Smith, R.P., *See* Knutson, C.F., 15:32190
Smith, S.A., *See* Deonigi, D.E., 15:32467
Smith, S.J., *See* Arnett, K., 15:33380
Snook, P., *See* McManamy, T.J., 15:33807
Snyder, A., *See* Wagner, S.R., 15:33416
Snyder, R.P., *See* Mercer, J.W., 15:32236
Soda, Kunihisa, *See* Hidaka, Akihide, 15:32369
Soderberg, D.J., *See* Furlong, M.W., 15:32061, 15:32062
Sofianos, S.A., *See* Oehm, W., 15:33563
Sokoloff, J.P., Low-frequency relaxation modes and structural disorder in $KTa_{1-x}Nb_xO_3$, 15:32764 (J;US)
Sokoloff, M.D., An experimental study of the A-dependence of J/psi photoproduction, 15:33527 (R;BR)
Solonenko, O.P., *See* Lyagushkin, V.P., 15:33627
Soltwisch, H., Measurement of the internal magnetic field structure of tokamak plasmas, 15:33778 (R;DE;In German)
Somorjai, G.A., *See* Vandentop, G.J., 15:32770
Song Quanxun, Some factors affecting the accuracy of uranium content determined by DNC measurement, 15:32970 (R;CN;In Chinese)
Soo, P., *See* Kempf, C.R., 15:32200
Sorem, M., *See* Graham, G., 15:32891
Souers, P.C., *See* Collins, G.W., 15:32674
Soulat, P., *See* Miannay, D., 15:32533
Sousa, D.C., *See* Akovali, Y.A., 15:33551
South, D.W., *See* Guziel, K.A., 15:32318
Southon, J.R., Injection systems for AMS: Simultaneous vs. sequential, 15:32943 (R;US)
The new LLNL AMS spectrometer, 15:32942 (R;US)
See Davis, J.C., 15:32941
See Proctor, I.D., 15:32944
See Vogel, J.S., 15:33196
Souza, J.H., Apple interface for experimental instrumentation and control-Pulse counter, timer, digital-to-analog converter, step motor and relays, 15:33004 (R;BR;In Portuguese)
Souzis, A.E., Solid state cesium ion guns for surface studies, 15:33363 (J;US)
Spandau, D.J., *See* Senum, G.I., 15:33116
Sparks, C.J., *See* Porter, W.D., 15:32585
Sparlin, D.M., *See* Yu, Chikung J., 15:32669
Spelt, P.F., Experimentation and concept formation by an autonomous mobile robot, 15:32843 (R;US)
Spence, R.D., Immobilization of technetium in blast furnace slag grouts, 15:32245 (BA;US)
Spencer, J.E., Accelerator diagnosis and control by Neural Nets, 15:32949 (BA;US)
Spicer, W.E., *See* Wahi, A.K., 15:32757
Spindler, B., Assessment of TRAC-PF1/MOD1 version 14.3 using separate effects critical flow and blowdown experiments: Volume 1, Test and tables, 15:32423 (R;US)

Assessment of TRAC-PF1/MOD1 Version 14.3 using separate effects critical flow and blowdown experiments: Volume 2, Figures, 15:32424 (R;US)
Spineanu, F., *See* Vlad, M., 15:33752
Sprey, H., *See* Aarts, J., 15:32596
Springett, G.D., *See* Debaets, M., 15:32368
Springhorn, S.S., *See* Cerritelli, S., 15:33203
Springston, S.R., *See* Dezaro, D.A., 15:32163
Sprott, J.C., *See* Dexter, R.N., 15:33810
Squillante, M.R., On-line monitor for metallic wear products. Phase 1. Final report, 15:32260 (R;US)
Squires, D.J., *See* Thomas, K.T., 15:32251
Srinivas Rau, S., A corollary to Kodaira-Spencer's theorem on continuity of eigenvalues, 15:33692 (R;XA)
On an isospectrality question over compact Riemann surfaces, 15:33691 (R;XA)
Srivastava, P.P., On BRST quantization of chiral bosonic particle, 15:33661 (R;BR)
Stadtkus, C., *See* Nehls, P., 15:33220
Staes, E.G., *See* Miller, C.T., 15:33169
Stahlnecker, E., *See* Fleming, B.A., 15:32058
See Furlong, M., 15:32060
Staley, C.S., *See* Bruns, D.A., 15:33124
Staley, L.J., Relationship between CO, POHC, and pic emissions from a simulated hazardous waste incinerator, 15:33086 (R;US)
Stallmann, F.W., *See* Kam, F.B.K., 15:32551
See Miller, L.F., 15:32338
Stanev, T., *See* Halzen, F., 15:33317
Stanislawski, J., *See* Gryzinski, M., 15:33817
Stappaerts, E.A., *See* Windisch, D.E., 15:32732
Starace, A.F., *See* Gao, B., 15:33360
Stassart, P., *See* Ripka, G., 15:33431
Stassis, C., *See* Miller, L.L., 15:32675
See Vaknin, D., 15:32676
Stauf, G.T., A comparison between energetics of decomposition and photo-deposition of Pd and Pt from $Pd(C_5H_5)(C_3H_5)$ and $Pt(C_5H_5)$, 15:32735 (BA;US)
Stechel, E.B., Pairing in CuO_6 driven by exchange interactions between carriers and localized Cu spins, 15:33633 (BA;US)
Steele, R., Preliminary observations of upcoming Phase II gate valve flow interruption tests, 15:32408 (RA;US)
Steele, R.T., *See* Hara, F.T., 15:32230
Steele, T.R., *See* Roe, N.A., 15:33412
Steidle, T.C., *See* Meroney, R.N., 15:32143
Steigman, J., *See* Pope, M., 15:32813
Stein, C., Bremsstrahlung induced by 50-MeV H^0 bombardment, 15:33639 (J;US)
Steinberg, M., Biomass and hydrocarb technology for removal of atmospheric CO_2, 15:32266 (R;US)
Steinitz, B., *See* Konjevic, R., 15:33206
Steizer, H., *See* Milkau, U., 15:33552
Stephan, P.L., *See* Chong, Y.P., 15:32946
Stephens, F.S., *See* Becker, J.A., 15:33558
Stephenson, R.L., *See* Moss, C.E., 15:33258
Sterer, E., A multipurpose miniature diamond anvil cell, 15:33014 (J;US)
Stermer, D.L., *See* Ayers, A.L. Jr., 15:32216
Stern, M., *See* Peters, N., 15:32317
Sternberg, N., *See* Godyak, V.A., 15:33830
Sterne, P., *See* Nicholson, D.M., 15:32564
Sternlieb, B., *See* Ansaldo, E.J., 15:32633
Stevens, A., Rad-hard electronics development program for SSC liquid-argon calorimeters, 15:32966 (R;US)
Stevens, M.F., Microstructural trapping effects on hydrogen induced cracking of a microalloyed steel, 15:32590 (J;US)
Stevens, R.G., *See* Stram, D.O., 15:33227
See Wilson, B.W., 15:33259
Stevens, R.R. Jr., *See* Smith, H.V. Jr., 15:33792
Stevenson, J.D., Seismic uplift of nuclear containments, 15:32386 (RA;US)
Stewart, A.J., *See* Boston, H.L., 15:33139
Stewart, C.C., *See* Salzman, G.C., 15:33214
Stewart, D.K., *See* Bu, Y., 15:33646
Stewart, J.H. Jr., *See* Bayne, C.K., 15:33119
Stewart, W.F., Safe venting of hydrogen, 15:32265 (R;US)
Stice, N.D., *See* Windisch, C.F. Jr., 15:32511
Stiffler, S.R., Nucleation of amorphous germanium from supercooled melts, 15:32752 (J;US)
Stinton, D.P., Mechanical property characterization of fiber-reinforced SiC matrix composites, 15:32071 (R;US)
Stobbs, W.M., *See* Alexander, K.B., 15:32537
Stockli, M.P., The KSU cryogenic electron-beam ion source, 15:32953 (J;US)
Stockman, H.S., Accretion shock geometries in the magnetic variables, 15:33309 (R;US)
Stocks, G.M., *See* Nicholson, D.M., 15:32564
Stockton, M.B., *See* Campbell, D.L., 15:33088
Stodden, C.D., Muon reactivation in muon-catalyzed *d-t* fusion from accurate *p*-He^+ stripping and excitation cross sections, 15:33368 (J;US)
Stodolsky, F., *See* Cole, R.L., 15:32502
Stoeckel, H., *See* Vlad, M., 15:33752
Stoeckel, J., Electrostatic edge turbulence on CASTOR tokamak, 15:33751 (RA;CS)
See Hildebrandt, D., 15:33753
See Weixelbaum, L., 15:33756
Stoker, A.W., v-src induces clonal sarcomas and rapid metastasis following transduction with a replication-defective retrovirus, 15:33207 (J;US)
Stokes, D.L., *See* Bello, J.M., 15:32796
Stoppkotte, W.O., *See* Boyes, J.D., 15:32945
Stotzky, G., Methods to measure the influence of genetically engineered bacteria on ecological processes in soil, 15:32281 (R;US)
Stovall, J.P., *See* Lawler, J.S., 15:32429
Stowers, I.F., Materials Fabrication Division/Precision Engineering Program Combined Bibliography (1970–1989), 15:32530 (R;US)
Straatman, J.T.H., *See* Schrama, J.T.A., 15:32291
Strachan, D.M., *See* McGrail, B.P., 15:33279
Stram, D.O., Smoking and serum proteins in atomic bomb survivors in Hiroshima, 15:33227 (R;JP)
Strange, R., *See* Battle, P.D., 15:32667
Straszheim, W.E., Assessment of coal cleanability for various beneficiation processes by SEM-based automated image analysis, 15:32089 (J;NL)
Strathdee, J., *See* Randjbar-Daemi, S., 15:33500
Strathdee, J.A., *See* Randjbar-Daemi, S., 15:33497
Strayer, M.R., Lattice calculation of muon-pair production with capture in relativistic heavy-ion collisions, 15:33593 (J;US)
Street, R.A., *See* Cho, Gyuseong, 15:32977
Street, R.L., *See* Koseff, J.R., 15:33391
Strip, D., Archimedes: An experiment in automating mechanical assembly, 15:32856 (R;US)
Stromatt, R.W., *See* Hara, F.T., 15:32230
Stroud, R.K., *See* Setmire, J.G., 15:33164
Struve, K.W., *See* Fawley, W.M., 15:32926
Stutzin, G.C., *See* Smith, H.V. Jr., 15:33792
Su, J.J., Plasma lenses for focusing particle beams, 15:32929 (J;US)
Su, Z.B., Self-consistent hole motion and spin excitations in a quantum antiferromagnet, 15:33621 (R;XA)
See Pang, H.B., 15:33620
Subramanian, M.A., *See* Toby, B.H., 15:32630
Subudhi, M., *See* Villaran, M., 15:32412
Sudan, R.N., *See* Similon, P.L., 15:33832
Suehiro, M., Development of fixed-bed-type hot-gas-cleanup technology for coal-derived gas, 15:32072 (R;JP)
Suekane, F., *See* Abe, K., 15:32978
Sugahara, Ryuhei, A colloidal solution of Fe_3O_4 crystallites to optically locate the magnetic center of multipole magnets, 15:32934 (R;JP)
Sugai, Hiroyuki, *See* Ishitsuka, Etsuo, 15:32547
Sugano, K., *See* Abachi, S., 15:33420
Sugar, R.L., *See* Gottlieb, S., 15:33516
Sugawara, Satoru, Validation of film dryout model in a three-fluid code FIDAS, 15:32870 (R;JP)
See Sakai, Takaaki, 15:32869
Sugihara, Ryo, Multi-laser beam accelerator, 15:33819 (RA;JP)
Sugimoto, Jun, *See* Hidaka, Akihide, 15:32369
See Okubo, Tsutomu, 15:32373

Sulanke, T., *See* Kartik, S., 15:33411
Sulentic, J.W., *See* Xu Cong, 15:33292
Sulkanen, M.E., Pulsar magnetospheres with jets, 15:33323 (J;US)
Sumarlin, I.W., *See* Lynn, J.W., 15:32680
Summerfelt, S.R., *See* Carter, C.B., 15:32634
Sun Maorong, *See* Liu Dechang, 15:32191
Sun Weifan, *See* Li Zhenping, 15:33599
Sun, J.D., *See* Mewhinney, J.A., 15:33223
Sunaga, Hiromi, Development of high-power X-ray generation target for radiation processing, 15:32933 (R;JP;In Japanese)
Supkoff, D., Monitoring for genetically engineered pseudomonas species in monterey county, 15:32282 (R;US)
Suresh, S., Cyclic damage zones ahead of tensile fatigue cracks in ceramic materials, 15:32608 (R;US)
Fatigue crack growth in ceramic materials at ambient and elevated temperatures, 15:32610 (R;US)
Susnitzky, D.W., *See* Carter, C.B., 15:32634
Sutter, R.J., *See* Chrien, R.E., 15:33533
Sutton, S.R., *See* Flynn, G.J., 15:33304
Suzuki, Katsuo, *See* Shimazaki, Junya, 15:32344
Suzuki, M., *See* Kawashima, N., 15:33608
Suzuki, T., *See* Imai, T., 15:32272
Suzuki, Toshio, *See* Takeishi, Hideyo, 15:32371
Suzuki, Yoshiaki, *See* Yamane, Yoshihiro, 15:32850
Svalter, B.F., *See* Svalter, N.F., 15:33665
Svalter, N.F., Casimir effect in a d-dimensional flat spacetime and the cut-off method, 15:33665 (R;BR)
Svensmark, H., Perturbed period-doubling bifurcation. I. Theory, 15:33719 (J;US)
Svidunovich, N.A., Application of low-temperature plasma generators for intensification of melting processes in induction furnaces, 15:33628 (RA;CS;In Russian)
Swadley, W.C., Geologic map of the surficial deposits of the Yucca Flat area, Nye County, Nevada, 15:33278 (R;US)
Swangley, W.A., *See* Myers, S.M., 15:33344
Swanson, C., Development of the oil-water monitor: Quarterly progress report No. 3, 15:33005 (R;US)
Swartz, T.E., *See* Ayers, W.B., 15:32106
Swenson, C.A., *See* Anderson, M.S., 15:32593
Swift, G.W., *See* Boyd, S.T.P., 15:33394
Swindeman, R.W., *See* Lundin, C.D., 15:32045
Swisher, J.H., Thermal methods for healing defects in protective oxide films on alloys, 15:32543 (RA;US)
Sykes, H., Consolidated list of chemicals subject to reporting under the Emergency Planning and Community Right-To-Know Act: SARA (Superfund Amendments and Reauthorization Act of 1986) Section 302 Extremely Hazardous Substances, CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act) Hazardous Substances and SARA Section 313 Toxic Chemicals (Title III. List of Lists) (for microcomputers). Data file, 15:32449 (R;US)
Sysoev, V.M., *See* Boyko, V.G., 15:33296
Szabados, L., 3.5% cold leg break test without hydroaccumulator application: Computerized measurement analysis, 15:32375 (R;HU;In Hungarian)
Szalewicz, K., *See* Stodden, C.D., 15:33368
Sze, R.C., Review of long-pulse laser development, 15:32894 (BA;US)
Szigeti, J., *See* Fussmann, G., 15:33760
Szpaklewicz, M.J., *See* Sharma, B., 15:32127

T

Tabatabai, A.S., *See* Jamison, J.D., 15:32419
Tabisz, G.C., *See* El-Sheikh, S.M., 15:32817
Taft, S.O., *See* Burnham, A.K., 15:32529
Taghva, K., *See* Baltz, D.W., 15:33838
Tahara, S., *See* Fork, D.K., 15:32631
Tajima, T., *See* Geary, J.L., 15:33795
Takagi, A., *See* Alton, G.D., 15:32957
Takano, K., *See* Morris, D.E., 15:32686
Takatsu, Tamao, *See* Watanabe, Katsutoshi, 15:32546
Takeiri, Toshiki, *See* Watanabe, Katsutoshi, 15:32546
Takeishi, Hideyo, Determination of the long-lived nuclides in biological shielding concrete, ion exchange resin and fuel storage pool water of JPDR, 15:32371 (R;JP;In Japanese)
Takeuchi, A.Y., Effects of A1 substitution by Fe in $CeAl_2$, 15:32531 (R;BR)
Takeuchi, S., Cross-field acceleration in plasmas, 15:33780 (RA;JP)
Takeyama, M., Effect of preoxidation and grain size in ductility of a boron-doped Ni_3Al at elevated temperatures, 15:32571 (BA;US)
Takigawa, M, 17_{ONMR} study of $YBaa_2Cu_3O_{7-\delta}$, 15:32658 (BA;US)
Takumi, K., Proving Test on the Reliability for Reactor Containment Vessel, 15:32388 (RA;US)
Talley, G.M., *See* Arnold, S.D., 15:33234
Tallman, C., Preionization techniques for discharge lasers, 15:32889 (BA;US)
Talukdar, B., Continuum states of the Klein-Gordon equations for vector and scalar interactions, 15:33668 (R;XA)
Talwar, I., *Ad hoc* Coulomb corrections to the radiation tail, 15:33587 (J;US)
Tamai, M., *See* Imai, T., 15:32272
Tamarit, F.A., *See* Cannas, S.A., 15:33610
Tan, T.Z., *See* Meroney, R.N., 15:32143
Tanaka, N., *See* Saito, H., 15:32390
Tanaka, Susumu, *See* Sunaga, Hiromi, 15:32933
Tanase, Masakazu, *See* Ishitsuka, Etsuo, 15:32547
Tandy, P.C., *See* Elster, C., 15:33589
Tang, H.T., *See* Dameron, R.A., 15:32399
Tang, J., *See* Beaudry, B.J., 15:32644
See Isoya, J., 15:32775
See Norris, J.R., 15:32818
Tang, X., The many faces of resonances in multiphoton ionization, 15:33348 (J;US)
See Charalambidis, D., 15:33372
Tang, Y.C., *See* Fujiwara, Y., 15:33579
Tanimori, Toru., Recent results of JANZOS, 15:33295 (RA;JP)
Tanis, J.A., *See* Belkacem, A., 15:33635
See Bernstein, E.M., 15:33381
Tao Ruibao, *See* Lin Zhifang, 15:33624
Tao, W.C., Burning mechanism and regression rate of RX-35-AU and RX-35-AV as a function of HMX particle size measured by the hybrid closed bomb-strand burner, 15:33031 (R;US)
Taranko, E., *See* Taranko, R., 15:33625
Taranko, R., On hydrogen chemisorption on metals: The electron correlation effects, 15:33625 (R;XA)
Tardy, D.C., Calculation of vibrational-energy-transfer quantities at high temperatures. Energy and temperature dependence, 15:32839 (J;US)
Taroni, A., *See* Watkins, M.L., 15:33766
Tasaka, H., *See* Ikuse, H., 15:32244
Tatani, A., *See* Kouno, S., 15:32315
Tataronis, J.A., *See* Roberts, D.R., 15:33796
Tatterson, D.F., *See* Fleming, B.A., 15:32058
Taura, T., Experimental studies of V_pxB electron linear accelerator, 15:32909 (RA;JP)
Tavares, O.A.P., *See* Lima, D.A. de, 15:33539
Taylor, J., *See* Gunther, W., 15:32413
Taylor, R.D., *See* Sterer, E., 15:33014
Taylor, R.W., *See* Burnham, A.K., 15:32166
Teague, M.E., Simultaneous NO_x/SO_2 removal with dry sorbent injection, 15:32314 (RA;US)
Temmerman, W.M., *See* Nicholson, D.M., 15:32564
Templeton, D.A., *See* Hedrick, J.B., 15:32461
Tench, R.J., *See* Schildbach, M.A., 15:32716
Tectonic Sobrinho, P., *See* Ferreira, L.A., 15:33702
Terazawa, Hidezumi, Super-hypernuclei in the quark-shell model, 3, 15:33571 (R;JP)
Terry, M.D., *See* Winokur, P.S., 15:32881
Tesmer, J.R., *See* Hirvonen, J.P., 15:32649
Thellesen, H.Z., Poly aromatic hydrocarbons in flue gas from straw-fueled boilers: Pilot investigation, 15:32271 (R;DK;In Danish)
Thieberger, P., Relativistic heavy ions from the BNL [Brookhaven National Laboratory] booster medical research and technological applications, 15:32907 (R;US)
Thiede, M.E., *See* Link, S.O., 15:32227
Thiel, P.A., *See* Evans, J.W., 15:33650

Thilly, W.G., *See* Keohavong, P., 15:33204
Thomas, D.K., *See* White, C.W., 15:32995
Thomas, D.L., *See* Hara, F.T., 15:32230
Thomas, D.M., *See* Huang, L.K., 15:33799
Thomas, E.W., *See* Xu, Y., 15:33371
Thomas, G., *See* Hetherington, C.J.D., 15:33012
See Rai, R.S., 15:32636
Thomas, K.L., *See* Kloeck, W., 15:33306
Thomas, K.T., Public understanding of radioactive waste management issues: Perspectives and the IAEA's role, 15:32251 (J;XA)
Thomas, L.E., *See* McCarthy, J.M., 15:32726
Thomas, M.P., *See* Huang, L.K., 15:33799
Thomas, M.T., *See* Carneiro, C.E.I., 15:33663
Thomas, R.L., Strategic Petroleum Reserve Program: Salt dome geology and cavern stability analysis, Bayou Choctaw, Louisiana: Final report, Appendix, 15:32160 (R;US)
Thompson, J.D., *See* Canfield, P.C., 15:32695
See Hundley, M.F., 15:32683
See Oseroff, S.B., 15:32677
See Severing, A., 15:32591
See Takigawa, M, 15:32658
Thompson, M.O., *See* Stiffler, S.R., 15:32752
Thompson, R.E., *See* Teague, M.E., 15:32314
Thunborg, S., *See* Christensen, B., 15:32858
Tian Jiafu, Analysis of economics and market for urban nuclear heating in China, 15:32330 (R;CN;In English and Chinese)
Tiegs, T.N., Microwave processing of silicon nitride, 15:32605 (R;US)
Tietz, L.A., *See* Carter, C.B., 15:32634
Timko, R.J., *See* Piacitelli, G.M., 15:33073
Timmerman, C.L., *See* Ikuse, H., 15:32244
Ting, K., *See* Baw, J.I., 15:32401
Tingey, J.M., Interdroplet attractive forces in AOT water-in-oil microemulsions formed in subcritical and supercritical solvents, 15:32815 (J;US)
Tinsley, J., *See* Ransome, R.D., 15:33532
Tirpak, D.A., *See* Lashof, D.A., 15:33079
See Smith, J.B., 15:33069, 15:33070, 15:33071, 15:33072
Tiryaki, A., An instability theorem for a certain sixth order differential equation, 15:33670 (R;XA)
Periodic solutions of certain fifth order differential equations, 15:33685 (R;XA)
Tischler, J.Z., *See* Eres, D., 15:32739
Titus, J.L., *See* Desko, J.C. Jr., 15:32988
Tluchor, Z., *See* Pavlo, P., 15:33754
Tobin, M.T., Electrical power from Inertial Confinement Fusion: Issues and prospects: Revision 1, 15:33823 (R;US)
Toby, B.H., Ordering in $Tl_2CaBa_2Cu_2O_8$ and $Tl_2Ba_2CuO_6$ studied by pair distribution function and Rietveld analysis, 15:32630 (BA;US)
Todd, I.W., Containment integrity beyond the design basis: A UK regulatory view, 15:32378 (RA;US)
Toerock, Gy., *See* Cser, L., 15:32353
Tojyo, E., *See* Tokuda, N., 15:32923
Tokarz, R., Recriticality in a boiling water reactor following a core damage accident, 15:32404 (RA;US)
Tokuda, N., Structure and RF characteristics of the INS 25.5-MHz split coaxial RFQ, 15:32923 (R;JP)
Tokuhara, Kazumi, *See* Yamashita, Kiyonobu, 15:32352
Toledo, E.M., *See* Loula, A.F.D., 15:33711
Tollin, G., Chlorophyll photochemistry in microheterogeneous media, 15:32279 (R;US)
Tomasek, F., Determination of neutron flux densities in WWR-S reactor core, 15:32355 (R;CS;In Czech)
Tomasi, E., *See* Eckert, E.M., 15:33559
Tombal, P., *See* Demaret, J., 15:33521
Tomic, J., *See* Schobert, H.H., 15:32053
Tomlinson, G.C., *See* Gray, D., 15:32079
Tomio, L., *See* Dey, J., 15:33442
Tomkins, B.A., Ultratrace determination of formaldehyde in potable water, 15:33256 (BA;US)
Tomko, J., *See* Peters, N., 15:32317
Tomlins, G., *See* Shaked, H., 15:32688
Tompkins, J.C., *See* Baggett, M.J., 15:32931
Tong, J., *See* Britten, J.A., 15:32836
Tonon, T., Development of a catalytic infrared cooking gas burner, 15:32178 (R;US)
Tooman, T.P., *See* Rogers, J.N., 15:33022
Torquato, S., Rigorous bounds on the fluid permeability: Effect of polydispersivity in grain size, 15:33389 (J;US)
Torres, J., *See* Novello, M., 15:33284
Torster, K., *See* Fleming, B.A., 15:32058
Torti, R., *See* Pu, Y.K., 15:32954
Tortorelli, P.F., *See* DeVan, J.H., 15:32553
Tosatti, E., *See* Wang, X.Q., 15:33626
Tosi, M.P., *See* Lai, S.K., 15:32805
Toth, K.S., *See* Akovali, Y.A., 15:33551
Tou, T.Y., *See* Blackwell, B.D., 15:33727, 15:33803
Touchton, R.A., Nuclear power applications of NASA control and diagnostics technology: Volume 1, Project results: Final report, 15:32341 (R;US)
Nuclear power applications of NASA control and diagnostics technology: Volume 2, Technical report: Final report, 15:32342 (R;US)
Nuclear power applications of NASA control and diagnostics technology: Volume 3, Users manual: Final report, 15:32343 (R;US)
Tovar, M., *See* Oseroff, S.B., 15:32677
Tranquada, J.M, Neutron scattering studies of magnetic correlations in the layered cuprates, 15:32659 (BA;US)
Trappe, K., *See* Aichinger, H.M., 15:32501
Trautmann, W., *See* Milkau, U., 15:33552
Trauw, F., *See* Epperson, J.E., 15:32621
Travis, C.C., *See* Hetrick, D.M., 15:33136
Treece, R.K., *See* Sexton, F.W., 15:33853
Trivers, D., Retrofit of a hog finishing barn to natural ventilation, 15:32507 (R;CA)
Troesch, O., *See* Jouve, A., 15:33117
Trost, J.T., Isolation of a photoactive photosynthetic reaction center - core antenna complex from Heliobacillus mobilis, 15:32287 (J;US)
Trott, W.M., High-power Nd:glass laser transmission through optical fibers and its use in acceleration of thin foil targets, 15:32999 (J;US)
Trotter, D.S., *See* Rajala, S.A., 15:33090
Trotter, R.S., *See* Vineyard, M.F., 15:33534
Trouw, F., *See* Eastman, J.A., 15:32622
Truax, D.R., *See* Kostelecky, V.A., 15:33377
Trugenberger, C.A., *See* Dunne, G.V., 15:33515
Tsai, W.S., *See* Siriwardane, H.J., 15:32172
Tsakalakos, T., Critical phenomena in nanoscale multilayer materials, 15:32565 (BA;US)
Tsallis, C., *See* Cannas, S.A., 15:33610
See Kawashima, N., 15:33608
See Mariz, A.M., 15:33611
See Martins, M.L., 15:33609
See Silva, E. de P. da, 15:33613
Tsang, M.N., Alternative solvents/technologies for paint stripping: Phase 1, 15:32505 (R;US)
Tsao, J.Y., *See* Horn, K.M., 15:32584
Tsinober, A.B., Circumfluous motion of a conductive liquid around solid objects in a magnetic field, 15:33607 (R;US)
Tsintsadze, N.L., *See* Jain, V.K., 15:33739
Tsuchino, S., *See* Ikuse, H., 15:32244
Tsugawa, R.T., *See* Collins, G.W., 15:32674
Tsujimoto, Tadashi, Proceeding of the symposium on the plan for establishment of Health Physics Research Center, 15:32254 (R;JP;In Japanese)
Tuckerman, D.B., *See* Barfknecht, A.T., 15:32714
Tullius, M., Glasses in the system phosphorus-sulfur: A ^{31}P spin-echo and high-speed MAS-NMR study of atomic distribution and local order, 15:32816 (J;US)
Tully, J.C., *See* Johnson, P.D., 15:33637
Tuomisto, H., Ice melting progress in a nonuniformly loaded ice condenser facility, 15:32383 (RA;US)
Tura, M.A.C., Acoustic and elastic diffraction tomography and its application to fracture detection, 15:33262 (R;US)
Turhollow, A., *See* Marland, G., 15:32270
Turner, A.P.L., *See* Shah, V.N., 15:32407

Turner, C.D., Coupled biological downflow fluid bed reactor treatment of synfuels wastewater, 15:33189 (BA;US)
See Riley, D.J., 15:33036
Turner, J.E., *See* Yoshida, H., 15:33231
Turner, L.R., Electromagnetic computations for fusion devices, 15:33731 (R;US)
Turner, M.G., Potential responses of landscape boundaries to global environmental change, 15:33051 (R;US)
Turner, W.C., *See* Bowles, E.E., 15:32940
Turnock, S.R., Two-dimensional wind tunnel tests of the SSS Series 1 structurally efficient aerofoils for wind turbines, 15:32308 (R;GB)
Turteltaub, K.W., *See* Davis, J.C., 15:32941
See Vogel, J.S., 15:33196
Tuttle, B.A., Characterization of chemically prepared PZT thin films, 15:32712 (R;US)

U

Uchida, Masaaki, Benchmarking of FEMAXI-IV code with fuel irradiation data in power reactors, 15:32320 (R;JP;In Japanese)
Udovic, T.J., Hydrogen vibrational modes and anisotropic potential in α-ScH_x, 15:32682 (J;US)
Udseth, H.R., *See* Smith, R.D., 15:33198
Uehara, Shozo, The Weil-Petersson Kaehler form on the super Teichmueller space, 15:33478 (R;JP)
Ueno, A., *See* Alton, G.D., 15:32957
Ukawa, N., *See* Imai, T., 15:32272
Uko, L.U., An error estimate for Tremolieres method for the discretization of parabolic variational inequalities, 15:33699 (R;XA)
The location of zeros using generalizations of Newton's method, 15:33698 (R;XA)
Ulloa, S.E., *See* Zhang, J., 15:33651
Ullschmied, J., Some results of diamagnetic measurements on Rebex machine, 15:33743 (RA;CS)
See Ripa, M., 15:33745
Umar, A.S., *See* Strayer, M.R., 15:33593
Umezawa, A, Temperature dependence of the lower critical field of single crystal $YBa_2Cu_3O_{7-\delta d}$, 15:32655 (BA;US)
Urie, M.W., *See* Hara, F.T., 15:32230
Utsunomiya, H., Quasifree fragmentation of radioactive projectiles: Extended Serber model, 15:33592 (J;US)

V

Vadas, S.L., *See* Holman, R., 15:33285
Vaeth, M., *See* Pierce, D.A., 15:33229
Vaklil, F., *See* Haver, J.F., 15:32431
Vaknin, D., Antiferromagnetism in $Sr_2CuO_2Cl_2$, 15:32676 (J;US)
See Pei, S., 15:32687
Valencia, G., Neutral-Higgs-boson contribution to the electric dipole moment of the neutron, 15:33464 (J;US)
Valenti, G., *See* James, C., 15:33414
Valentinetti, R., Technology evaluation report: SITE program. CF Systems organics extraction system, New Bedford, Massachusetts. Volume 1. Final report, 15:33178 (R;US)
Technology evaluation report: SITE program. CF Systems organics extraction system, New Bedford, Massachusetts. Volume 2. Final report, 15:33179 (R;US)
Valovic, M., Control of plasma position on the Castor tokamak, 15:33750 (RA;CS)
See Weixelbaum, L., 15:33756
van Berkel, G.J., *See* McLuckey, S.A., 15:32795
Van Berkel, G.J., Geoporphyrin analysis using an ion trap mass spectrometer, 15:32165 (BA;US)
Van Bibber, K., *See* Countryman, P.J., 15:33561
Van DeVaide, D.M., *See* Boyes, J.D., 15:32945
Van Kooten, R., *See* Jung, C.K., 15:33415
Vance, S.L., *See* Jansen, I.J., 15:32102, 15:32103
Vandentop, G.J., Formation of hydrogenated amorphous carbon films of controlled hardness from a methane plasma, 15:32770 (J;US)
Vandervoort, K.G., *See* Kwok, W.K., 15:32654
See Umezawa, A, 15:32655
Vandiver, P.B., *See* Ellingson, W.A., 15:32629
VanFleet, H.B., *See* Dabrowski, B., 15:32619
Vankov, H.P., *See* Halzen, F., 15:33317
VanKulken, J.C., *See* Veselka, T.D., 15:32470
Vareka, W.A., *See* Kwiat, P.G., 15:32767
Varner, J.E., [Hydroxyproline-rich glycoproteins of the plant cell wall]: Progress report, June 1989–June 1990, 15:33193 (R;US)
Vavrina, R.D., *See* Iverson, J.R., 15:32516, 15:32517
Vawter, G.A., Chlorine reactive-ion-beam etching of InSb and $InAs_{0.15}Sb_{0.85}$/InSb strained-layer-superlattices, 15:32713 (R;US)
Veal, B.W., *See* Shaked, H., 15:32688
Velsko, S., *See* Norton, M., 15:32885
Velsko, S.P., The chemistry and physics of nonlinear optical materials: A new look at an old field, 15:32994 (BA;US)
Vemuri, G., Exact results on light scattered from atoms pumped by coherent and chaotic fields of arbitrary bandwidth, 15:33382 (J;US)
Venturini, E.L., *See* Ansaldo, E.J., 15:32633
See Halloran, J.W., 15:32616
Veres, G., *See* Kalvin, S., 15:33755
Verghese, S., Fabrication of a high T_c superconducting bolometer, 15:32989 (R;US)
Vernon, S.M., *See* Blakeslee, A.E., 15:32733
Verry, M., *See* Willemot, J.M., 15:32778
Veselka, T.D., Introduction to the Argonne Utility Simulation (ARGUS) model, 15:32470 (R;US)
The Argonne Utility Simulation model: An analysis tool for evaluating energy and environmental strategies, 15:32097 (R;US)
Veskovic, M., Quadrupole moments and band-mixing in tungsten nuclei, 15:33595 (J;US)
Vetrano, J.S., Cascade collapse in copper and nickel, 15:32540 (R;US)
Viccaro, P.J., Spectral characteristics of insertion device sources at the Advanced Photon Source, 15:32932 (R;US)
Vier, D.C., *See* Oseroff, S.B., 15:32677
Viescas, A.J., *See* Johnson, P.D., 15:33637
Vigil, M.G., Graphical analysis of barrel-tamped explosively accelerated flyer plates, 15:33027 (R;US)
Vijaya Sankar, M.K., Transport simulation of the effect of impurity radiation on the high beta, ohmic start-up of the HBT-EP tokamak, 15:33733 (R;US)
Villaran, M., Instrument air system - Aging impact on system availability, 15:32412 (RA;US)
Vineyard, M.F., Energy dependence of fusion evaporation-residue cross sections in the $^{28}Si+^{28}Si$ reaction, 15:33534 (J;US)
Viola, V.E., *See* Kwiatkowski, K., 15:33550
See Planeta, R., 15:33549
See Yennello, S.J., 15:33542
Violet, C.E., Local oxygen configurations relative to $F_e$probe ions in $HoBa_2{}^{Cu}{}_{0.95}{}^{Fe}{}_{0.053}{}^{O}{}_{7-x}$, 15:32663 (BA;US)
See Winter, N.W., 15:32640
Virole, J., *See* Debaets, M., 15:32368
Visscher, W.M., *See* Migliori, A., 15:32679
Viswanathan, R., Classical extended conformal symmetries, 15:33502 (R;XA)
Vitomirov, I.M., *See* Waddill, G.D., 15:32600
Viviani, M., *See* Wang, X.Q., 15:33626
Vlad, M., A model for the electrostatic turbulence observed in the Castor tokamak, 15:33752 (RA;CS)
Vo, T.V., *See* Jamison, J.D., 15:32419
Vo-Dinh, T., *See* Bello, J.M., 15:32796
See Johnson, R.W., 15:32793
Vogel, J.S., Application of AMS [accelerator mass spectrometry] to the biomedical sciences, 15:33196 (R;US)
See Southon, J.R., 15:32942, 15:32943
Volgt, J.A., Processing chemically prepared $YBa_2Cu_3O_7$ precursor powders: Extraction preparation and applications, 15:32898 (BA;US)
See Tuttle, B.A., 15:32712
Volakis, J.L., *See* Ricoy, M.A., 15:32705
von Holtz, E., Paste extrudable explosives: Their history and their current status, 15:33032 (R;US)
Von Schweber, E., Natural language interfaces to data-base systems. Final report, April-August 1988, 15:33857 (R;US)

Vorres, K.S., Sulfur species in perchloroethylene and other coal extracts, 15:32780 (R;US)
Voter, A.F., *See* Clapp, P.C., 15:32563
Vrba, P., Simulation of relativistic electron and ion flows, 15:33339 (RA;CS)

W

Waddell, J.T., *See* Brooks, G.W., 15:33083, 15:33087
Waddill, G.D., Abrupt interfaces with novel structural and electronic properties: Metal-cluster deposition and metal-semiconductor junctions, 15:32600 (J;US)
Wade, D.C., Trends versus reactor size of passive reactivity shutdown and control performance, 15:32427 (J;US)
Wade, G., *See* Patt, B.E., 15:32973
Wagener, T.J., O 2*p* holes: Temperature effects and surface characteristics of cuprate superconductors, 15:32689 (J;US)
Wagner, A.F., Experimental and theoretical studies of the $C_2H_5 + O_2$ reaction kinetics, 15:32840 (J;US)
Study of the recombination reaction $CH_3+Ch_3 \rightarrow C_2H_6$: Theory, 15:32274 (BA;US)
Wagner, S.R., Measurement of the B^0-meson lifetime, 15:33416 (J;US)
Wagner, W., *See* Beier, G., 15:33540
Wagner, W.T., The influence of data collection rate, containment size and data smoothing on containment Integrated Leak Rate Tests, 15:32387 (RA;US)
Wahl, A.K., Interfacial chemistry of metals on CdTe and ZnTe (110), 15:32757 (J;US)
Waldron, M.C., *See* White, A.R., 15:33181
Walet, N.R., Generalized valley approximation applied to a schematic model of the monopole excitation, 15:33585 (J;US)
Wall, K.C., *See* Davidson, A., 15:33458
Walker, D., Paleotectonic significance of the quartzite of the Sauratown Mountains window, North Carolina, 15:33282 (J;US)
Walker, T.J., The AFLC ECAMP [Environmental Compliance Assessment and Management Program] experience: How it was done and lessons learned, 15:32442 (R;US)
Walker, W.M., *See* Jansen, I.J., 15:32102, 15:32103
Wall, M.A., *See* Huang, J.S., 15:32645
Wallace, R.G., *See* Dudney, C.S., 15:33111
Walsh, B.W., Prediction of miscible flood performance: The effect of dispersion on composition paths in ternary systems, 15:32135 (J;US)
Walters, E.J., Center for Electronics and Electrical Engineering Technical Progress Bulletin covering Center programs, July to September 1989, with 1990 CEEE events calendar, 15:32466 (R;US)
Walther, S.R., Production of atomic nitrogen ion beams, 15:33347 (J;US)
See Langbein, K., 15:32955
See Leung, K.N., 15:33366
Walton, O.R., *See* Heuze, F.E., 15:33039
Waluklewicz, W., *See* Bliss, D.E., 15:32755
Wampler, W.R., Trapping of deuterium at damage in graphite, 15:32710 (R;US)
Wander, J.D., *See* Buelow, S.J., 15:32806
Wanderer, P., *See* Goodzeit, C., 15:32930
Wang Guojuan, *See* Liu Dechang, 15:32191
Wang Hongwei, *See* Feng Weiguo, 15:33622
Wang Shikun, Superconformal algebra and central extension of meromorphic vector fields with multipoles on super-Riemann sphere, 15:33490 (R;XA)
See Chang Zhe, 15:33498
See Guo Hanying, 15:33681
Wang Shouzhong, *See* Zheng Hualing, 15:32195
Wang Zhibo, *See* Li Zhenping, 15:33599
Wang Zhiming, *See* Li Zhenping, 15:33599
Wang, J.A., *See* Kam, F.B.K., 15:32551
Wang, N., Electrical and thermal properties of neutron-transmutation-doped Ge at 20 mK, 15:32595 (J;US)
Wang, S., *See* Lee, H.P., 15:32729
Wang, S.X., *See* Miller, L.L., 15:32675
Wang, X.L., *See* Miller, L.L., 15:32675
Wang, X.Q., Correlated basis function method for fermions on a lattice: The 1-dimensional Hubbard model, 15:33626 (R;XA)
Wang, Yun, *See* Holman, R., 15:33285, 15:33286
Wang, Z., *See* Ross, J.H. Jr., 15:32766
Warburton, E.K., Mass systematics for A=29–44 nuclei: The deformed A~32 region, 15:33591 (J;US)
See Mach, H., 15:33543
Ward, K.J., The infrared microspectroscopic determination of a polymer dopant using partial and classical least-squares chemometric methods, 15:32794 (BA;US)
Ward, M.B., *See* Deason, V.A., 15:32991
Ward, T.E., Genetic manipolation of acidophilic bacteria, 15:32077 (BA;US)
Ware, A.G., Mechanical damage experience in major light water reactor systems, 15:32364 (R;US)
Warklaw, D.M., *See* Wagner, A.F., 15:32274
Warner, R.C., *See* Minahan, J.A., 15:33519
Warrell, R., *See* Bockman, R., 15:33212
Watanabe, H., *See* Kawata, S., 15:33340
Watanabe, Katsutoshi, Filler metal development for hastelloy alloy XR, 15:32546 (R;JP;In Japanese)
Watanabe, Koichi, *See* Shimazaki, Junya, 15:32344
Watanabe, Kunihiko, *See* Horiuchi, Ritoku, 15:33738
Waterland, L.R., Operations and research at the US EPA Incineration Research Facility: Annual report for FY89, 15:33089 (R;US)
Watkins, C.S., *See* Ward, T.E., 15:32077
Watkins, M.L., Modelling the pumped divertor: Workshop held at JET on 25/26 September 1989, 15:33766 (RA;GB)
Watson, C.C., *See* Gregory, D.I., 15:32099
Watson, J.S., Improvements in macroreticular particles for ion-exchange and gel-permeation chromatography, 15:32700 (R;US)
Watson, R.E., The energetics associated with the formation of interfaces, multilayers and adlayers, 15:32812 (BA;US)
Watts, R.L., *See* Deonigi, D.E., 15:32467
Waugh, W.J., *See* Link, S.O., 15:32227
Weatherby, J.R., Post-test analysis of a piping penetration in a 1:6-scale model of a reinforced concrete containment building, 15:32400 (RA;US)
Weaver, H.A., The volatile composition of comets, 15:33301 (R;US)
Weaver, H.T., *See* Carson, R.F., 15:33043
Weaver, J.H., *See* Waddill, G.D., 15:32600
See Wagener, T.J., 15:32689
Weaver, W.L., The RELAP5/MOD3 computer code, 15:32363 (R;US)
Weber, E.R., *See* Lee, H.P., 15:32729
Weber, G.F., Simultaneous SO_x/NO_x control: Technical report, April 1, 1987–March 31, 1988 including Quarterly technical progress report, January–March 1988, 15:32310 (R;US)
Weber, G.J., *See* Corley, J.P., 15:32911
Weber, K.E., Ceramic valve development for heavy-duty low heat rejection diesel engines, 15:32521 (J;US)
Weeks, R.A., Correlation between optical absorption and refractive index of silica and silicate glasses implanted with copper, 15:32723 (BA;US)
Weidenhamer, G.H., *See* Shah, V.N., 15:32407
Weinberg, E.J., *See* Holman, R., 15:33285
Weinberg, V.M., *See* Popov, V.S., 15:33333
Weinberg, W.H., *See* Mullins, C.B., 15:32820
Weiner, K.H., Bipolar transistor fabrication using gas immersion laser doping, 15:32895 (BA;US)
Weinert, M., *See* Watson, R.E., 15:32812
Weir, A.J., Upper limits on $D^{\pm}$ and $B^{\pm}$ decays to two leptons plus $\pi^{\pm}$ or $K^{\pm}$, 15:33419 (J;US)
Weir, J.T., *See* Chong, Y.P., 15:32946
Weir, S.T., Effects of shock-induced defects on flux pinning in $YBa_2Cu_3O_{7-\delta}$, 15:32899 (BA;US)
Weisbin, C.R., *See* Beckerman, M., 15:32845
Weiss, A., *See* Mayer, R., 15:32982
Weixelbaum, L., Edge density profile studies in the Castor tokamak using a thermal lithium beam, 15:33756 (RA;CS)
See Stoeckel, J., 15:33751
Wellstood, F.C., *See* Wang, N., 15:32595
Welp, U., *See* Kwok, W.K., 15:32654
See Umezawa, A, 15:32655

Wendt, J.R., *See* Vawter, G.A., 15:32713
Wenzel, U., *See* Stoeckel, J., 15:33751
See Weixelbaum, L., 15:33756
Wernsman, B., CW ultraviolet and visible laser action from ionized silver in an electron beam generated plasma, 15:33790 (J;US)
Weseloh, W., *See* Curry, R.D., 15:33827
Wessels, B.W., *See* Pan, H.C., 15:32642
West, W.P., *See* Huang, L.K., 15:33799
Westbrook, C.K., *See* Britten, J.A., 15:32836
See Burcat, A., 15:32167
See Cowart, J.S., 15:32519
See Griffiths, J.F., 15:32837
See Wilk, R.D., 15:32520, 15:32789
Westmacott, K.H., *See* Hetherington, C.J.D., 15:33012
Whangbo, M.-H., Importance of weak hydrogen bonding C-H–donor and C-H–anion interactions in governing the structural properties of organic donors BEDT-TTF and BEDO-TTF and their charge-transfer salts, 15:32803 (R;US)
Whelan, G., Remedial Action Assessment System (RAAS): Evaluation of selected feasibility studies of CERCLA [Comprehensive Environmental Response, Compensation, and Liability Act] hazardous waste sites, 15:32229 (R;US)
Whetstone, S., Electron beam induced emission from carbon plasmas, 15:33828 (BA;US)
Whipkey, R., *See* McMillan, C., 15:32874
Whipple, R., *See* von Holtz, E., 15:33032
Whitaker, J.S., *See* Roe, N.A., 15:33412
White, A.R., Analysis of mutagenic activity of biohazardous organics in Kanawha River sediments. Technical completion report, 15:33181 (R;US)
White, C.M., On the nature of organosulfur constituents in Rasa lignite, 15:32107 (BA;US)
White, C.W., Ion implantation of Ti into $LiNbO_3$: Fabrication of waveguides and simple modulators, 15:32995 (BA;US)
See El-Ghor, M.K., 15:32746
See Sjoreen, T.P., 15:32740
White, G.J., *See* Bruns, D.A., 15:33124
White, G.K., Fiscal Year 1988 program report: Maine Environmental Studies Center, 15:32154 (R;US)
White, J.W., *See* Eastman, J.A., 15:32622
See Epperson, J.E., 15:32621
White, K.W., *See* Ghosh, A., 15:32652
White, M.V., *See* Huling, S.G., 15:32157
White, R.B., Canonical Hamiltonian guiding center variables, 15:33798 (J;US)
Influence of an energetic ion population on tokamak plasma stability, 15:33793 (J;US)
Whiteman, C.D., Effects of valley meteorology on forest pesticide spraying, 15:33219 (R;US)
Whitlow, L.W., Precise extractions of the x and Q^2 dependence of $R = \sigma_L/\sigma_T$, F_{2p}, F_{2d}, and $F_{2n}/_{2p}$ from a combined analysis of SLAC [Stanford Linear Accelerator Center] deep inelastic electron scattering experiments, 15:33433 (R;US)
Whitten, C.A. Jr., *See* Moshi, M.G., 15:33557
Whittier, J., Comparative performance analysis: Commercial cut-flower rose production, 15:33218 (R;US)
Whittum, D.H., *See* Autin, B., 15:32917
Wicks, G.G., *See* Covington, J.F. Jr., 15:32241
See Ramsey, W.G., 15:32213
Widrow, L.M., *See* Dodelson, S., 15:33512
Wiehr, K., Florestan-Material Test, 15:32374 (R;DE;In German)
Wieleczko, J.P., *See* Gomez del Campo, J., 15:33537
Wieliczka, D.M., Anomalous copper diffusion through samarium, 15:32751 (J;US)
Wiersma, G.B., *See* Bruns, D.A., 15:33124
Wilburn, C.D., *See* Jernigan, J.G., 15:32938
Wildermuth, D., *See* Cho, Gyuseong, 15:32977
Wilhite, E.L., Program for low-level radiactive waste disposal at the Savannah River Site, a U.S. nuclear materials production facility, 15:32248 (BA;US)
Wilk, R.D., Combustion of n-butane and isobutane in an internal combustion engine: A comparison of experimental and modeling results, 15:32520 (R;US)
Kinetic modeling of ethene oxidation at low and intermediate temperatures, 15:32789 (R;US)
Wilkins, B.D., *See* Vineyard, M.F., 15:33534
Willemot, J.M., Faster radiotoxicological analyses of alpha emitters, 15:32778 (R;FR;In French)
Williams, G.P., Infrared synchrotron-radiation transmission measurements on $YBa_2Cu_3O_{7-\delta}$ in the gap and supercurrent regions, 15:32691 (J;US)
Williams, J.A., A high-sensitivity, position-sensitive fission chamber for subcriticality measurement of spent fuel, 15:32197 (R;US)
Williams, J.M., *See* Whangbo, M.-H., 15:32803
Williams, M.D., Testing of a H_2^+-enriched ion source for deuterium simulation, 15:33349 (J;US)
Williams, R., Crossing-consistent analysis of kaon photoproduction and radiative capture, 15:33594 (J;US)
Williams, R.R., Effect of blast furnace coal injection upon bosh coke properties, coke combustion and furnace permeability, 15:32117 (R;XE)
Williams, T.L., *See* Patterson, S.R., 15:33038
Williamson, D.L., *See* Gessert, T.A., 15:32762
Williamson, R.L., A particle-level numerical simulation of the dynamic consolidation of a metal matrix composite material, 15:32612 (R;US)
See Hareland, W.A., 15:32792
See Korth, G.E., 15:32544
Willis, J.O., *See* Maley, M.P., 15:32656
Wilmarth, P.A., *See* Akovali, Y.A., 15:33551
Wilson, B.W., Extremely low frequency electromagnetic fields: The question of cancer, 15:33259 (B;US)
Wilson, D.L., First-phase study design for the US Navy Radon Assessment and Mitigation Program (NAVRAMP), 15:32481 (R;US)
See Gammage, R.B., 15:32480, 15:33049, 15:33118
Wilson, G.E., CSAU (code scaling, applicability and uncertainty), a tool to prioritize advanced reactor research, 15:32360 (R;US)
See Hanson, R.G., 15:32359
Wilson, J.M., Laser-triggered gas switch improvements on PBEA-II, 15:33829 (BA;US)
Wilson, K., *See* Wampler, W.R., 15:32710
Wilson, M., *See* Bhalla, C.P., 15:33376
Wilson, R.B. Jr., Low-temperature, sulfur-tolerant homogeneous catalysts for the water-gas shift reaction: Final report, 15:32050 (R;US)
Wilson, R.J., *See* Roe, N.A., 15:33412
Wiltowski, T., *See* Smith, G.V., 15:32057
Winans, R.E., Sulfur compounds in coals containing multiple heteroatoms, 15:32108 (BA;US)
See Neill, P.H., 15:32088
Windisch, C.F. Jr., Fiscal year 1989 annual report for the Sensors Development Program: Inert Electrodes Program, 15:32511 (R;US)
Windisch, D.E., A new tool for cellulose degradation studies, 15:32732 (BA;US)
Winger, J.A., *See* Mach, H., 15:33544
Winokur, P.S., Statistical process control for QML [Qualified Manufacturer's List] radiation hardness assurance, 15:32881 (R;US)
See Shaneyfelt, M.R., 15:32882
Winsborough, W., *See* Mulkers, A., 15:33843
Winter, N.W., Calculation of the nuclear quadrupole resonance spectra of $YBa_2Cu_3O_{7-x}$, 15:32640 (BA;US)
See Violet, C.E., 15:32663
Winter, T.G., *See* Stodden, C.D., 15:33368
Wiringa, R.B., *See* Pieper, S.C., 15:33583
Wise, M.B., Determination of airborne organics by direct sampling mass spectrometry, 15:33050 (R;US)
Rapid determination of nicotine in urine by direct thermal desorption ion trap mass spectrometry, 15:32782 (R;US)
See Isgur, N., 15:33455
Wisniewski, W.J., *See* Coffman, D., 15:33423
Witherspoon, J.P., *See* Miller, C.W., 15:33190
Witt, S., *See* Barrett, M., 15:32329
Wohn, F.K., *See* Mach, H., 15:33544, 15:33546
Wolf, D., Thermodynamic parallels between solid-state amorphization and melting, 15:33634 (J;US)
Wolf, G.H., *See* Reiter, D., 15:33779

Wolf, M., Microbial degradation of bitumen, 15:32706 (R;CH;In German)
Wolf, S.A., *See* Kresin, V.Z., 15:32690
Wolfe, J.C., *See* Setmire, J.G., 15:33164
Wolford, A.J., Aging risk assessment methodology: Demonstration study on a PWR auxiliary feedwater system, 15:32406 (RA;US)
Wonder, E.F., *See* Numark, N.J., 15:32218
Wong, Cheuk-Yin, Micropolyelectrons as possible sources of the anomalous positron peaks in heavy-ion reactions, 15:33566 (R;US)
Wong, F., *See* Lee, K.S.H., 15:32886
Woo, K.C., Hall effect mesurements in thin films of $Tl_2Ba_2CaCu_2O_x$, 15:32661 (BA;US)
Woo, L.W., *See* Yennello, S.J., 15:33542
Wood, B.J., *See* Wilson, R.B. Jr., 15:32050
Wood, L., Brilliant pebbles, 15:33044 (R;US)
Wood, T.R., Summary of the 1987 soil sampling effort at the Idaho National Engineering Laboratory Test Reactor Area Paint Shop Ditch, 15:33125 (R;US)
Woodcock, G.R., Transportation and operations aspects of space energy systems, 15:32263 (RA;US)
Woodruff, W.H., *See* Belhadj, M., 15:33202
Woodside, S.L., Encoding of the Burgess metal electrical resistivity model into SESAME format and its adaptation to the metal nickel, 15:32548 (R;US)
Woodward, J., Hydrolysis of cellobiose by immobilized β-glucosidase entrapped in maintanance-free gel spheres, 15:33215 (R;US)
See Offord, D.A., 15:33192
Woody, M.C., *See* Hagaman, E.W., 15:32086
Wootton, A.J., Texas Experimental Tokamak: Technical progress report, April 1989–April 1990, 15:33811 (R;US)
See Huang, L.K., 15:33799
See Ritz, C.P., 15:33736
Wordin, J.J, Plug valve, 15:32859 (P;US)
Worth, G.T., *See* Smith, H.V. Jr., 15:33792
Wortman, D.N., *See* Robbins, C.L., 15:32486
Wreathall, J., The development and evaluation of programmatic performance indicators associated with maintenance at nuclear power plants: Main report: Volume 1, 15:32420 (R;US)
The development and evaluation of programmatic performance indicators associated with maintenance at nuclear power plants: Appendices: Volume 2, 15:32421 (R;US)
Wright, E.K., *See* Loeppke, G.E., 15:32300
Wright, F., *See* Oseroff, S.B., 15:32677
Wright, L.E., *See* Talwar, I., 15:33587
Wright, R.N., *See* Williamson, R.L., 15:32612
Wroblewski, D., *See* Huang, L.K., 15:33799
Wu Ke, *See* Chang Zhe, 15:33498
Wu Xiang, *See* Feng Weiguo, 15:33622
Wu Zhenying, *See* Zheng Weimin, 15:33217
Wu, G., *See* Meroney, R.N., 15:32143
Wu, J., *See* Smith, L., 15:33080
Wu, J.S., Evaluation of detention-basin performance in the Piedmont region of North Carolina, 15:33180 (R;US)
Wu, M.K., *See* Huang, W.F., 15:32678
Wu, Ting-shu, Characterization of high damping bearings and their responses to earthquake motions, 15:32842 (R;US)
Wu, Yu-Shu, A comparison of analytical approaches for wellbore heat transmission in layered formations, 15:33261 (R;US)
Wudka, J., External sources for topologically massive gauge fields, 15:33513 (J;US)
Wulck, S., *See* Mignaco, A.J., 15:33429
See Mignaco, J.A., 15:33475
Wuosmaa, A.H., *See* Mordechai, S., 15:33535

X

Xia, W., Moving species during ion mixing in Ge_xSi_{1-x}/metal systems, 15:32760 (J;US)
Xiang, T., *See* Pang, H.B., 15:33620
Xiao Hongchai, *See* Tian Jiafu, 15:32330
Xie, M., Eigenmode analysis of optical guiding in free-electron lasers, 15:32904 (J;US)
Xie, Y., Group fellowship training in nuclear spectroscopy instrumentation maintenance at the Seibersdorf Laboratories, 15:32983 (J;XA)
Xin Yunwei, *See* Chen Tianlun, 15:33489
Xu Cong, Quantifying the FIR interaction enhancement in paired galaxies, 15:33292 (R;XA)
Xu Kaiwen, *See* Chang Zhe, 15:33498
See Guo Hanying, 15:33681
See Wang Shikun, 15:33490
Xu Xiang, *See* Feng Weiguo, 15:33623
Xu, G., *See* Shek, M., 15:32594
Xu, N., *See* Piel, W.F. Jr., 15:33548
Xu, Y., Charge-transfer reactions of ground-state $C^+(^2P)$ and metastable-state $C^+(^4P)$ ions with H_2 molecules, 15:33371 (J;US)
Electronic structure and optical properties of LiB_3O_5, 15:32696 (J;US)
Xu, Z., *See* Loveland, W., 15:33555
Xu, Z.J., *See* Huang, W.F., 15:32678
Xuhai, Xu, Potential performance of methods for parallelism across time in ODEs, 15:33844 (R;US)

Y

Yamada, T., Numerical simulations of the mountain iron tracer data, 15:33061 (R;US)
Yamaguchi, M., *See* Al-Jassim, M.M., 15:32724
Yamakawa, K., *See* Daido, H., 15:32936
Yamamoto, A., *See* Al-Jassim, M.M., 15:32724
Yamane, Yoshihiro, Spatial dependence of the spectral-ratio in Mihalczo method, 15:32850 (RA;JP;In Japanese)
Yamashita, Kiyonobu, Evaluation of reactivity coefficients for High Temperature Engineering Test Reactor (HTTR), 15:32352 (R;JP;In Japanese)
The conceptual design of High Temperature Engineering Test Reactor upgraded through utilizing Pebble-in-Block fuel (UHTTR), 15:32323 (R;JP;In Japanese)
Yan, H., Roughening phase transition in surface growth, 15:33638 (J;US)
Yanagi, M., *See* Imai, T., 15:32264
Yanase, Nobuyuki, *See* Amano, Hikaru, 15:33063
Yang Fucun, *See* Zheng Weimin, 15:33217
Yang, F.C., *See* Lee, K.S.H., 15:32886
Yang, H.R., *See* Fussmann, G., 15:33818
Yang, J.M., Reinforcement/matrix interaction in SiC fiber-reinforced Ni_3Al matrix composites, 15:32582 (BA;US)
Yang, L.H., Electronic properties of Si-Ge micro nipi structures: Fundamentals, structure, and devices, 15:32741 (BA;US)
Yang, T.R., *See* Williams, G.P., 15:32691
Yang, W.J.S., Beta-quenched Zircaloy-4: Effects of thermal aging and neutron irradiation, 15:32583 (BA;US)
Yang, X.Z., *See* Huang, L.K., 15:33799
Yao Hesheng, *See* Feng Weiguo, 15:33623
Yarmoff, J.A., *See* Joyce, S.A., 15:32720
Yarrington, P., *See* Hertel, E.S., 15:32873
Yasui, Yukinori, *See* Uehara, Shozo, 15:33478
Yeerian, M.R., *See* Countryman, P.J., 15:33561
Yeh, C.Y., *See* Lin, S.H., 15:32801
Yen, S.C., Comminution employing liquid nitrogen pretreatments, 15:32040 (RA;US)
Yennello, S.J., Intermediate mass fragment emission in the 161-MeV p+Ag reaction, 15:33542 (J;US)
Yip, S., *See* Wolf, D., 15:33634
Yocum, C.F., *See* Babcock, G.T., 15:32286
Yoder, M.J., *See* Peter, R.A., 15:32893
Yokoyama, A., Molecular beam studies of the photodissociation of benzene at 193 and 248 nm, 15:32828 (J;US)
Yokoyama, Jun'ichi, *See* Berkin, A.L., 15:33288
Yonezawa, Chushiro, *See* Takeishi, Hideyo, 15:32371
Yoo, M.H., *See* Fu, C.L., 15:32561
Yoo, S.H., *See* Mordechai, S., 15:33535
Yoshida, H., Measurement of free ammonia produced by X irradiation of glycylglycine in aqueous solution, 15:33231 (J;US)

Yoshikawa, S., Temperature distribution of a tokamak with a constant heat conductivity, 15:33785 (R;US)
You, H., *See* Chang, H.L.M., 15:32606
Young, A.T., *See* Smith, H.V. Jr., 15:33792
Young, C.E., Conservation Reserve Program: An economic assessment. Agricultural economic report, 15:32457 (R;US)
See Arlinghaus, H.F., 15:32748
Young, K.D., A hierarchical approach to large space structure control, 15:32497 (R;US)
Yu, Chikung J., High-temperature defect structure of Nb-doped $LaCrO_3$, 15:32669 (J;US)
Yu, L., *See* Ioffe, L., 15:33652
See Pang, H.B., 15:33620
See Su, Z.B., 15:33621
See Wang, X.Q., 15:33626
Yu, P., *See* Lee, H.P., 15:32729
Yu, P.Y., *See* Kim, D., 15:33636
Yu, Z.Z., *See* Clapp, P.C., 15:32563
Yudanin, B., *See* Cai, W., 15:33645
Yue, W., *See* Feng, Qiao, 15:32827
Yugami, N., *See* Taura, T., 15:32909
Yunus, A., *See* Talukdar, B., 15:33668
Yust, C.S., Friction and wear of whisker-reinforced ceramic composite bodies, 15:32609 (R;US)
Yuta, H., *See* Abe, K., 15:32978

Z

Zacek, F., *See* Hildebrandt, D., 15:33753
See Stoeckel, J., 15:33751
See Vlad, M., 15:33752
See Weixelbaum, L., 15:33756
Zafindratafa, G., On Einsteinian 4-submanifolds in E^6, 15:33669 (R;XA)
Zagwijn, P., *See* Aarts, J., 15:32596
Zamick, L., *See* Zheng, D.C., 15:33580
Zanolin, F., *See* Afuwape, A.U., 15:33676
Zapata, F., FAO/IAEA research and training in soil fertility at the IAEA's Seibersdorf Laboratories, 15:33839 (J;XA)
Zarembe, E., *See* Nuroh, K., 15:33332
Zdrazil, S., *See* Neufuss, K., 15:33629
Zehner, D.M., *See* Kang, M.H., 15:32597
Zhang, J., Electronic modes and infrared optical excitation in tunneling superlattices, 15:33651 (J;US)
Zhang, Shou-Yuan, Applications of modern filtering to accelerators, 15:32913 (BA;US)
Zhao Motian, *See* Deng Zhongguo, 15:32779
Zhao, X., *See* Yokoyama, A., 15:32828
Zhao, Xiao Kang, Electrochemical characterization of bilayer lipid membrane-semiconductor junctions, 15:32763 (J;US)
Zhen, Z., *See* Cavagnero, M., 15:33367
Zheng Hualing, The extraction of Eu^{+3} from simulated high level liquid waste of nuclear power reactor reprocessing by centrifugal extractors, 15:32195 (R;CN;In Chinese)
Zheng Weimin, Possibility of rubidium-86 as a tracer of potassium and its application in agriculture as a tracer, 15:33217 (R;CN;In Chinese)
Zheng, D.C., Forward scattering of a proton from a J=1 nucleus: Selection rules for flipping the spin of the target by two units, 15:33580 (J;US)
Zheng, T.F., *See* Cai, W., 15:33645
Zhou Shunli, *See* Zheng Hualing, 15:32195
Zhou, D.F., *See* Blackwell, B.D., 15:33803
Zhou, S.H., *See* Kwiatkowski, K., 15:33550
See Planeta, R., 15:33549
See Yennello, S.J., 15:33542
Zhu Chuanjie, 2+1 topological term, anyons and their possible application in high T_c superconductivity, 15:33496 (R;XA)
Zhu Zhennan, *See* Li Zhenping, 15:33599
Zimanyi, J., *See* Levai, P., 15:33445
Zimerman, A.H., *See* Ferreira, L.A., 15:33702
Zimmerman, T.A., *See* Proctor, I.D., 15:32944
Zinder, S.H., [Conversion of acetic acid to methane by thermophiles]: Progress report, May 15, 1985–May 15, 1990, 15:32267 (R;US)
Zinkle, S.J., Microstructural characterization of Al_2O_3 following simultaneous triple ion bombardment, 15:32648 (BA;US)
Zinn, B.T., Pulsating burners - controlling mechanisms and performance. Annual report, January 1-December 31, 1988, 15:32183 (R;US)
Ziolkowski, R., *See* Barth, M., 15:32887
Zitter, R.N., *See* Malhotra, V.M., 15:32038
Zocco, T.G., *See* Hirvonen, J.P., 15:32649
Zoletnik, S., *See* Kalvin, S., 15:33755
Zou Jingke, *See* Liu Dechang, 15:32191
Zubersky, J.L., *See* Hernandez, L. Jr., 15:33863
Zucca, J.J., Seismic imaging for velocity and attenuation structure in geothermal fields, 15:32297 (R;US)
Zuhr, R., *See* Weeks, R.A., 15:32723
Zuhr, R.A., Metal silicides formed by direct ion beam deposition, 15:32627 (BA;US)
Zurek, W.H., *See* Kheyfets, A., 15:33715
Zygelman, B., QED potentials in many-electron atoms, 15:33350 (J;US)

Subject Index

This index is arranged by subject descriptors selected from those assigned to each citation in this publication. Subject descriptors are selected from a controlled thesaurus of terms, *EDB Subject Thesaurus* (DOE/OSTI-7000). In order to enhance indexing, subject descriptor entries generally consist of a pair of descriptors: a main term and a qualifier term. Each entry includes the full title (which may be followed by supplementary descriptive information in parentheses) and the citation number. Additional information given in parentheses indicates the document type (an abbreviation such as B for book), the country of publication (such as DE for Federal Republic of Germany), and the language if non-English.

See references guide users from synonymous terms to the descriptors selected for the concept. *See also* references indicate subject concepts that are more specific than a particular descriptor. To gain complete subject coverage, all such terms should be reviewed.

A

A CODES
Analytical correlation and post-test analysis of the Sandia 1:6 scale reinforced concrete containment test, 15:32399 (RA;US)

A RESONANCES
See MESONS

A-BOMB SURVIVORS
Radiation-related posterior lenticular opacities in Hiroshima and Nagasaki atomic bomb survivors based on T65DR and DS86 dosimetry systems, 15:33228 (R;JP)
Smoking and serum proteins in atomic bomb survivors in Hiroshima, 15:33227 (R;JP)
The shape of the cancer mortality dose-response curve for atomic bomb survivors, 15:33229 (R;JP)

A2H-1320 RESONANCES
See MESONS

A2L-1280 RESONANCES
See MESONS

ABANDONED SITES
Multimedia assessment of health risks for the Weldon Spring site remedial action project, 15:32202 (R;US)
The environmental compliance process at New York FUSRAP [Formerly Utilized Sites Remedial Action Program] sites, 15:32253 (R;US)

ABSORBED DOSES
See RADIATION DOSES

ABSORPTION
About rainbow scattering in the presence of absorption, 15:33338 (R;FR)

ABSORPTION SPECTRA
On the dynamic polarizability of atoms, 15:33332 (R;XA)

ACCELERATOR FACILITIES
See also STANFORD LINEAR COLLIDER
LLNL/UC [Lawrence Livermore National Laboratory]/[University of California] AMS [accelerator mass spectrometry] facility and research program, 15:32941 (R;US)
The new LLNL AMS spectrometer, 15:32942 (R;US)

ACCELERATORS
See also CYCLIC ACCELERATORS
LINEAR ACCELERATORS
MESON FACTORIES
PARTICLE BEAM FUSION ACCELERATOR
WAKEFIELD ACCELERATORS
Accelerator diagnosis and control by Neural Nets, 15:32949 (BA;US)
Control system for the Neutron Therapy Facility at Fermilab, 15:32915 (BA;US)
Development and testing of the Hermes-III pulse forming transmission lines, 15:32911 (BA;US)
Electron beam induced emission from carbon plasmas, 15:33828 (BA;US)
Engineering design of the Saturn accelerator, 15:32945 (BA;US)
Injection systems for AMS: Simultaneous vs. sequential, 15:32943 (R;US)
Kinematic moment invariants for linear Hamiltonian systems, 15:33717 (J;US)
Proceedings of the impedance and bunch instability workshop, 15:32919 (R;US)

ACCIDENTAL IRRADIATION
See RADIATION ACCIDENTS

ACCRETION (STARS)
See STAR ACCRETION

ACES
See QUARKS

ACETATES
[Conversion of acetic acid to methane by thermophiles]: Progress report, May 15, 1985–May 15, 1990, 15:32267 (R;US)

ACID RAIN
Evaluating cumulative effects of disturbance on the hydrologic function of bogs, fens, and mires, 15:33174 (R;US)
Evaluation of the role of ozone, acid deposition, and other airborne pollutants in the forests of eastern North America. Forest Service general technical report, 15:33085 (R;US)
National Acid Precipitation Assessment Program (NAPAP) county-level alkaline emission estimates for unpaved roads. Dust Devils and wind erosion, 1985 (for microcomputers). Data file, 15:33094 (R;US)
National Performance Audit Program: Acid rain audits, 1988, 15:33082 (R;US)
Ozone and acid-precipitation on western coniferous forests, 15:33134 (R;US)

ACOUSTIC AGGLOMERATORS
Acoustic agglomeration of power plant fly ash for environmental and hot gas cleanup: Final report: Revised Version, 15:32311 (R;US)

ACTINIDES
See also CALIFORNIUM
PLUTONIUM
THORIUM
URANIUM
Approximate energy correction for particle number symmetry breaking in constrained Hartree-Fock plus BCS calculations, 15:33586 (J;US)
Electrochemical reduction of actinide ions in aqueous solution and some examples of its application, 15:32833 (R;FR)
Faster radiotoxicological analyses of alpha emitters, 15:32778 (R;FR;In French)

ACTIVITY LEVELS
Report of radioactivity survey research in fiscal year 1988, 15:33602 (R;JP;In Japanese)

ADENOCARCINOMAS
See CARCINOMAS

ADIRONDACK MOUNTAINS
Trace fossils and bioturbation in peritidal facies of the Potsdam-Theresa Formations (Cambrian-Ordovician), Northwest Adirondacks, 15:33281 (J;US)

ADVANCED TEST IDAHO REACTOR
See ATR REACTOR

ADVECTION
A preliminary evaluation of ADPIC [atmospheric diffusion particle-in-cell] model performance on selected ANATEX [Across North America Tracer Experiment] releases using observed, analyzed, and dynamically predicted winds, 15:33109 (R;US)

AEROSOL GENERATORS
Aerosol cloud generation experiments, 15:33026 (R;US)

AEROSOL WASTES
See also FLY ASH
Urban modeling of organic aerosol source emissions, 15:33047 (R;US)

AEROSOLS
A parametric investigation of electrical effects on aerosol scavenging by droplets over large fires, 15:33108 (R;US)
Aerosol Dynamics Laboratory, 15:33000 (R;US)
Aerosol cloud generation experiments, 15:33026 (R;US)
Numerical simulation of aerosol scavenging by ice-bearing convective clouds, 15:33104 (R;US)
Parameterization of aerosol scavenging in a convective cloud model, 15:33105 (R;US)

AGING
Aging risk assessment methodology: Demonstration study on a PWR auxiliary feedwater system, 15:32406 (RA;US)

AGRICULTURE
Conservation Reserve Program: An economic assessment. Agricultural economic report, 15:32457 (R;US)

AIR
First-phase study design for the US Navy Radon Assessment and Mitigation Program (NAVRAMP), 15:32481 (R;US)
Radiological effluents released from announced US continental tests, 1961 through 1988, 15:33035 (R;US)
Radiological oversight and certification report for the Lansdowne property, 105-107 East Stratford Avenue, Lansdowne, Pennsylvania, August 1988–June 1989, 15:33114 (R;US)

AIR FILTERS
Rapid determination of plutonium content on filters and smears using Alpha Liquid Scintillation, 15:32974 (R;US)

AIR FLOW
Node-based network analysis and its application to mine ventilation, 15:32876 (BA;US)
Three-dimensional computer modeling of particulate flow around dust monitors, 15:32877 (BA;US)

AIR POLLUTION
See also INDOOR AIR POLLUTION
Cumulative impacts on water-quality functions of wetlands, 15:33173 (R;US)
Evaluation of the role of ozone, acid deposition, and other airborne pollutants in the forests of eastern North America. Forest Service general technical report, 15:33085 (R;US)
National Dry Deposition Network: Second annual progress report (1988), 15:33092 (R;US)
Nature demands stricter limits, 15:32105 (R;NL)
Ozone and acid-precipitation on western coniferous forests, 15:33134 (R;US)
Policy options for stabilizing global climate. Draft report to congress. Executive Summary. Draft report, 15:33079 (R;US)
Potential Effects of Global Climate Change on the United States. Appendix B. Sea-level rise. Report to the Congress, 15:33070 (R;US)
Potential Effects of Global Climate Change on the United States. Appendix G. Health. Report to the Congress, 15:33071 (R;US)
Potential Effects of Global Climate Change on the United States. Appendix H. Infrastructure. Report to the Congress, 15:33069 (R;US)
Potential Effects of Global Climate Change on the United States. Appendix L. Variability. Report to the Congress, 15:33072 (R;US)

AIR POLLUTION CONTROL
Air toxics compliance issues and case histories from the Kentucky experience, 15:32450 (BA;US)
Nature demands stricter limits, 15:32105 (R;NL)

AIR POLLUTION MONITORING
Precision and accuracy assessments for state and local air-monitoring networks, 1988, 15:33080 (R;US)

AIR POLLUTION MONITORS
Air pollution: National air monitoring network is inadequate, 15:33058 (R;US)
Continuous emission monitoring of hazardous waste incinerators using Fourier transform infrared spectroscopy, 15:33110 (BA;US)

AIR QUALITY
Annual technical report for the onshore environmental baseline characterization, 15:32161 (R;US)
Precision and accuracy assessments for state and local air-monitoring networks, 1988, 15:33080 (R;US)

AIR SAMPLERS
Surface acoustic wave (SAW) gas microsensor for SO_2. Final report, 15:33084 (R;US)

AIRBORNE PARTICLES
See PARTICULATES

AIRBORNE PARTICULATES
See PARTICULATES

AIRCRAFT
Reserve force: DOD guidance needed on assigning roles to reserve under the total policy, 15:32469 (R;US)

AIRFOILS
Two-dimensional wind tunnel tests of the SSS Series 1 structurally efficient aerofoils for wind turbines, 15:32308 (R;GB)

ALABAMA
Superfund Record of Decision (EPA Region 4): Ciba-Geigy (McIntosh Plant), AL. (First remedial action), September 1989, 15:33176 (R;US)

ALCOHOLS
See also METHANOL
Evaluation of mixed alcohol production processes and catalysts, 15:32273 (R;US)

ALGAE
Toxicity bioassays: Water pollution effects on aquatic animals and plants. June 1986-February 1990 (A bibliography from the Selected Water Resources Abstracts data base). Report for June 1986-February 1990, 15:33183 (R;US)

ALGEBRA
A remark on Euclidean-domain types, 15:33697 (R;XA)
Beltrami algebra and symmetry of Beltrami equation on Riemann surfaces, 15:33681 (R;XA)

ALGEBRAIC FIELD THEORY
Geometrical properties of an internal local octonionic space in a non-Riemannian manifold, 15:33662 (R;BR)

ALKALI METALS
See also CESIUM
LITHIUM
POTASSIUM
SODIUM
Reply to "Comment on 'Fine-structure and analytical quantum-defect wave functions' ", 15:33377 (J;US)
Strong-field laser ionization of alkali atoms using two-dimensional cylindrical and three-dimensional Cartesian time-dependent Hartree–Fock theory, 15:33358 (J;US)
Thermodynamics and structure of liquid alkali metals from the charged-hard-sphere reference fluid, 15:32805 (R;XA)

ALKALINE EARTH METALS
See also BARIUM
BERYLLIUM
CALCIUM
STRONTIUM
Reply to "Comment on 'Fine-structure and analytical quantum-defect wave functions' ", 15:33377 (J;US)

ALKANES
See also CYCLOALKANES
ETHANE
METHANE
OCTANE
Proton affinities and pK_a values of tetraalkylhydrazines, 15:32823 (J;US)

ALKENES
See also ETHYLENE
HEXENES

Kinetic modeling of ethene oxidation at low and intermediate temperatures, 15:32789 (R;US)

ALKYL RADICALS
See also METHYL RADICALS
Experimental and theoretical studies of the $C_2H_5 + O_2$ reaction kinetics, 15:32840 (J;US)

ALKYLATES
See ALCOHOLS

ALLOY SYSTEMS
Effects of A1 substitution by Fe in $CeAl_2$, 15:32531 (R;BR)

ALLOY-1915
See ALUMINIUM BASE ALLOYS

ALLOY-214X
See ALUMINIUM BASE ALLOYS

ALLOY-50KH4N6G12F2V
See CHROMIUM ALLOYS

ALLOY-79NM
See NICKEL BASE ALLOYS

ALLOY-GE
See COPPER ALLOYS
SILVER ALLOYS

ALLOY-GMR-235
See NICKEL BASE ALLOYS

ALLOY-HD-8077
See NICKEL BASE ALLOYS

ALLOY-KH20N80T
See NICKEL BASE ALLOYS

ALLOY-KHN77TYU
See NICKEL BASE ALLOYS

ALLOY-M-252
See NICKEL BASE ALLOYS

ALLOY-MA-754
See NICKEL BASE ALLOYS

ALLOY-MA-956
See IRON BASE ALLOYS

ALLOY-MM-0011
See NICKEL BASE ALLOYS

ALLOY-NI49CR22FE18MO9
Filler metal development for hastelloy alloy XR, 15:32546 (R;JP;In Japanese)

ALLOY-WAZ-16
See NICKEL BASE ALLOYS

ALLOY-ZR98SN-4
See also ZIRCALOY 4
Heat treatments influence on mechanical properties of zircaloy 4 - particular study of fatigue structures, 15:32534 (R;FR;In French)

ALLOYS
See also ALUMINIUM ALLOYS
BERYLLIUM ALLOYS
CHROMIUM ALLOYS
COPPER ALLOYS
GERMANIUM ALLOYS
GOLD ALLOYS
IRON ALLOYS
NICKEL ALLOYS
NIOBIUM ALLOYS
RARE EARTH ALLOYS
REFRACTORY METALS
SILVER ALLOYS
TITANIUM ALLOYS
TUNGSTEN ALLOYS
VANADIUM ALLOYS
ZIRCONIUM ALLOYS
Health and safety guide for inorganic compounds and metals used in the fabrication of superconductive alloys, 15:33234 (R;US)
Metal matrix composites from dynamic consolidation of powder mixtures, 15:32544 (R;US)
Multicomponent ultrafine microstructures, 15:32617 (B;US)
Thermodynamic parallels between solid-state amorphization and melting, 15:33634 (J;US)

ALPHA REACTIONS
Direct measurement of the branching ratio Γ_n/Γ_f of ^{238}U in inelastic alpha scattering in the giant resonance region, 15:33561 (J;US)

ALPHA-BEARING WASTES
Buried waste program at the Idaho National Engineering Laboratory, 15:32249 (BA;US)
Offgas system particulate cleaning test and evaluation for the Process Experimental Pilot Plant, 15:32216 (R;US)
Proceedings of the US Department of Energy Office of Environmental Restoration and Waste Management waste reduction workshop 4, 15:32204 (R;US)
Program for low-level radiactive waste disposal at the Savannah River Site, a U.S. nuclear materials production facility, 15:32248 (BA;US)
Selection of immobilization technology for TRU [transuranic] waste, 15:32233 (R;US)

ALUMINIA
See ALUMINIUM OXIDES

ALUMINIUM
Abrupt interfaces with novel structural and electronic properties: Metal-cluster deposition and metal-semiconductor junctions, 15:32600 (J;US)
An atomic model of crack tip deformation in aluminum using an embedded atom potential, 15:32587 (J;US)
Bremsstrahlung induced by 50-MeV H^0 bombardment, 15:33639 (J;US)
Effects of A1 substitution by Fe in $CeAl_2$, 15:32531 (R;BR)
Effects of internal hydrogen on the vacancy loop formation probability in Al, 15:32539 (R;US)
Encoding of the Burgess metal electrical resistivity model into SESAME format and its adaptation to the metal nickel, 15:32548 (R;US)
Fiscal year 1989 annual report for the Sensors Development Program: Inert Electrodes Program, 15:32511 (R;US)
A dependence of highly inelastic *p*-nucleus collisions, 15:33418 (J;US)
A dependence of J/ψ production in π^--nucleus collisions at 530 GeV/*c*, 15:33411 (J;US)

ALUMINIUM ALLOYS
See also ALUMINIUM BASE ALLOYS
Corrosion
Study of metal corrosion using ac impedance techniques in the STS launch environment, 15:32549 (RA;US)
Crystal Structure
Stacking fault energies, crystal elasticity and their relation to the mechanical properties of $L1_2$-ordered alloys, 15:32561 (BA;US)
Structure maps and phase stability in $AlTi_3$ alloyed with rare-earth elements, 15:32562 (BA;US)
Crystal-Phase Transformations
Phase and microstructure of Fe modified Al_3Ti, 15:32585 (BA;US)
Crystallization
Surface energy anisotropy of diffusion-induced Ni_3Al crystals, 15:32567 (BA;US)
Deformation
An analysis of the low temperature, low and high strain-rate deformation of Ti-6Al-4V, 15:32589 (J;US)
Mechanism of achieving nanocrystalline AlRu by ball milling, 15:32566 (BA;US)
Diffusion
Reinforcement/matrix interaction in SiC fiber-reinforced Ni_3Al matrix composites, 15:32582 (BA;US)
Ductility
Effect of preoxidation and grain size in ductility of a boron-doped Ni_3Al at elevated temperatures, 15:32571 (BA;US)
Electronic Structure
Atomic and electronic structure of the NiAl(111) surface, 15:32597 (J;US)
Impedance
Study of metal corrosion using ac impedance techniques in the STS launch environment, 15:32549 (RA;US)
Irradiation
Phase stability of Ni_3Al_3 under electron irradiation, 15:32580 (BA;US)

Melting
Melting of iron-aluminide alloys, 15:32044 (R;US)
Metallurgical Effects
Effect of aluminum level on boron clustering in Ni_3Al, 15:32560 (BA;US)
The development of alloys based on Ni_3Si, 15:32578 (BA;US)
Oxidation
[Oxidation of intermetallics and ceramics]: Foreign trip report, March 23, 1990–April 12, 1990, 15:32553 (R;US)
Phase Studies
Amorphization of Zr_3Al by hydrogenation and subsequent electron irradiation, 15:32574 (BA;US)
Surfaces
Atomic and electronic structure of the NiAl(111) surface, 15:32597 (J;US)
Thermodynamic Properties
Some thermodynamic propeties of NiAl calculated by molecular dynamics simulations, 15:32563 (BA;US)
Welding
Weldability of nickel aluminides, 15:32542 (R;US)

ALUMINIUM ARSENIDES
Band-gap narrowing in ordered and disordered semiconductor alloys, 15:32750 (J;US)
Lattice-mismatched $In_{0.53}Ga_{0.47}As/In_{0.52}Al_{0.48}As$ modulation-doped field-effect transistors on GaAs: Molecular-beam epitaxial growth and device performance, 15:32772 (J;US)
Molecular beam epitaxy of $AlAs_{0.16}Sb_{0.84}$ and $Al_{0.8}Ga_{0.2}As_{0.14}Sb_{0.86}$ on InAs substrates, 15:32758 (J;US)
Temperature dependence of compositional disordering of GaAs-AlAs superlattices during MeV Kr irradiation, 15:32774 (J;US)

ALUMINIUM BASE ALLOYS
Identification of cleavage planes in the Al_3Ti-base alloy by electron channeling in the SEM, 15:32577 (BA;US)
Microstructure and mechanical properties of Ll_2-structure alloys based on Al_3Zr, 15:32576 (BA;US)
Structural energy differences in Al_3Ti: The role of tetragonal distortion in APB and twin energies, 15:32564 (BA;US)

ALUMINIUM NITRATES
Microencapsulation of silicon nitride particles with yttria and yttria-alumina precursors, 15:32668 (J;US)

ALUMINIUM NITRIDES
Microanalytical and structural characterization of optical materials by electron microscopy and related spectroscopies, 15:32637 (BA;US)

ALUMINIUM OXIDES
Annealing studies of B2FeAl, 15:32586 (BA;US)
Cyclic damage zones ahead of tensile fatigue cracks in ceramic materials, 15:32608 (R;US)
Electron microscopy of interfaces in silicon carbide whisker-reinforced alumina composites, 15:32699 (R;US)
Fatigue crack growth in ceramic materials at ambient and elevated temperatures, 15:32610 (R;US)
Friction and wear of whisker-reinforced ceramic composite bodies, 15:32609 (R;US)
Microanalytical and structural characterization of optical materials by electron microscopy and related spectroscopies, 15:32637 (BA;US)
Microstructural characterization of Al_2O_3 following simultaneous triple ion bombardment, 15:32648 (BA;US)
Properties of films prepared from low surface area/density alumina-silica, 15:32615 (R;US)
Subcritical crack growth in hot-isostatically postcompacted high-grade alumina, 15:32614 (R;CH)

ALUMINIUM SILICATES
See also SMECTITE
Cordierite-spinel troctolite, a new magnesium-rich lithology from the lunar highlands, 15:33283 (J;US)

ALUMINUM
See ALUMINIUM

ALVEOLI (PULMONARY)
See LUNGS

AMBERLITE
See ORGANIC ION EXCHANGERS

AMBIENT TEMPERATURE
Multi-dimensional aspects of recent climate change in North America: Progress report, August 15, 1989–April 1, 1990, 15:33054 (R;US)

AMERICAN INDIANS
Description and validation of a method for simultaneous estimation of effective population size and mutation rate from human population data, 15:33209 (J;US)

AMERICIUM 241
An aerial radiological survey of the United States Department of Energy's Rocky Flats Plant, Golden, Colorado: Date of survey, July 1989, 15:33057 (R;US)
Long-term stability of solid standards for radiochemical analysis, 15:32785 (R;US)

AMINO ALCOHOLS
See ALCOHOLS

AMMONIA
Measurement of free ammonia produced by X irradiation of glycylglycine in aqueous solution, 15:33231 (J;US)

AMMONIUM COMPOUNDS
See also AMMONIUM PERCHLORATES
Urban aerosol transformation and transport modeling. Report for October 1985-October 1988, 15:33091 (R;US)

AMMONIUM PERCHLORATES
Destruction of propellant components in supercritical water, 15:32806 (R;US)

ANALYSIS (STRUCTURAL CHEMICAL)
See STRUCTURAL CHEMICAL ANALYSIS

ANEMOMETERS
Accuracy of wind measurements and international intercalibration of anemometers, 15:32304 (R;NL;In Dutch)

ANIMAL CELLS
Chronobiological effects of electric fields, 15:33260 (BA;US)
JANUS neutron irradiation of a mouse cell line containing a shuttle vector plasmid, 15:33221 (R;US)

ANIMAL SHELTERS
Retrofit of a hog finishing barn to natural ventilation, 15:32507 (R;CA)

ANODES
Physical modeling of bubble phenomena, electrolyte flow and mass transfer in simulated advanced Hall cells: Final report, 15:32504 (R;US)

ANTARCTIC OCEAN
See SEAS

ANTARCTICA
Identification of oscillations in Ross Sea current data, 15:33280 (J;US)

ANTENNAS
Modeling pulse driven antenna systems with finite differences, 15:32887 (R;US)

ANTIFERROMAGNETIC MATERIALS
Upper critical field of a $Sm_{1.85}Ce_{0.15}CuO_{4-y}$ single crystal: Interaction between superconductivity and antiferromagnetic order in copper oxides, 15:32670 (J;US)

ANTIFERROMAGNETISM
Self-consistent hole motion and spin excitations in a quantum antiferromagnet, 15:33621 (R;XA)

ANTILAMBDA PARTICLES
The reaction anti pp → anti ΛΛ 92 MeV above the reaction threshold, 15:33402 (R;DE;In German)

ANTIMATTER
See also ANTIPARTICLES
Gravity and antimatter, 15:33713 (J;US)

ANTIMONY
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 4. Primary zinc, primary lead, secondary lead, primary antimony. Final report, 15:33157 (R;US)
New surface atomic structures for III-V(110)-p(1 x 1)-Sb(1ML): Chemical bonding and electronic structure, 15:32808 (R;US)

ANTIMONY COMPOUNDS
See also ANTIMONY OXIDES

Chlorine reactive-ion-beam etching of InSb and $InAs_{0.15}Sb_{0.85}$/InSb strained-layer-superlattices, 15:32713 (R;US)

ANTIMONY OXIDES
Chemistry and superconducting behavior of Sb-substituted Bi/Pb-based oxides, 15:32626 (BA;US)
Effect of electron and volume change via SB (V) doping on the superconducting behavior of $K_{0.14}Ba_{0.6}Bi_{1-x}Sb_xO_3$, 15:32625 (BA;US)

ANTIPARTICLES
Measurement of gravitational acceleration of antimatter, 15:33740 (R;XA)

ANTIPROTON BEAMS
Spin observables in antip-N elastic scattering, 15:33399 (R;FR)

APARTMENT BUILDINGS
Senior citizens retrofits: Final project summary, 15:32488 (R;CA)

APPALACHIAN MOUNTAINS
See also ADIRONDACK MOUNTAINS
Transport studies of radon in limestone underlying houses, 15:33118 (R;US)

APPLICATORS (RADIOTHERAPY)
See RADIATION SOURCES

AQUATIC ORGANISMS
See also AUFWUCHS
BENTHOS
FISHES
Metals testing report: Metal content of environmental samples from Region 4, 15:33250 (R;US)

AQUIFERS
Buried waste program at the Idaho National Engineering Laboratory, 15:32249 (BA;US)
Estimating pumping time and ground-water withdrawals using energy-consumption data. Water-Resources Investigation, 15:32460 (R;US)
Evaluation of ground-water extraction remedies. Volume 1. Summary report, 15:33166 (R;US)
Experimental determination of the flow speed of the Dogger geothermal aquifer in the Paris basin, 15:32294 (R;FR;In French)

ARABIDOPSIS
Dependence of the phototropic response of Arabidopsis thaliana on fluence rate and wavelength, 15:33206 (J;US)

AREA POLLUTION SOURCES
See POLLUTION SOURCES

ARGON
Indices governing optical self-focusing and self-induced changes in the state of polarization in N_2, O_2, H_2, and Ar gases, 15:32765 (J;US)
Melting and orientational epitaxy in argon and xenon monolayers on graphite, 15:32776 (J;US)
Phonons in solid argon monolayers, 15:32759 (J;US)
Precipitation of Ar, Kr and Xe in Ni at room temperature, 15:32730 (BA;US)
Variational methods for high-order multiphoton processes, 15:33360 (J;US)

ARGON 40 REACTIONS
Changes in target fragmentation mechanisms with increasing projectile energy in intermediate energy nuclear collisions, 15:33555 (J;US)
Fragment emission in the reaction $^{40}Ar+^{197}Au$ at E/A=30 and 220 MeV, 15:33552 (R;DE)
Measurements of time delays for projectile-like fragments in the reaction ^{40}Ar+Ge at 44 MeV/nucleon, 15:33537 (J;US)
Transient times of fission in $^{40}Ar+^{232}Th$ peripheral collisions, 15:33559 (R;DE)

ARGON IONS
Correlation enhancement of the electron-impact ionization cross section for excited-state Ne-like ions, 15:33370 (J;US)

ARMOR
A comparison of CTH predictions with experimental armor/anti-armor data for long rod penetrators in two and three dimensions, 15:32873 (R;US)
Modeling jet penetration in glass, 15:33033 (R;US)

ARMY PERSONNEL
See MILITARY PERSONNEL

AROMATIC COMPOUNDS
See AROMATICS

AROMATICS
See also BENZENE
BIPHENYL
DURENE
PHENOLS
POLYCYCLIC AROMATIC HYDROCARBONS
Behavior of phenol and aniline on selected sorbents and energy-related solid wastes, 15:32081 (J;NL)
Electron beam-induced fluorescence as a liquid chromatographic detection technique, 15:32163 (BA;US)

ARRAY PROCESSORS
PCGPAK for message passing multiprocessors. Final report on Phase 1, 15:33851 (R;US)
Solving large sparse linear systems of equations in a global shared-memory multiprocessing environment. Final report on Phase 1, 15:33852 (R;US)

ARSENIC
Concentrations of metals in Norton Sound seawater samples and human hair samples, 1989, 15:33188 (R;US)

ARSENIC COMPOUNDS
See also ARSENIC HYDRIDES
Chlorine reactive-ion-beam etching of InSb and $InAs_{0.15}Sb_{0.85}$/InSb strained-layer-superlattices, 15:32713 (R;US)

ARSENIC HYDRIDES
Theoretical study of GeH_n, AsH_n, and SeH_n: Ionization energies, 15:33384 (J;US)

ARSONIUM COMPOUNDS
See ARSENIC COMPOUNDS

ARTESIAN BASINS
Energetic up-grading of wells in arterian basins, 15:32275 (R;FR;In French)

ARTIFICIAL INTELLIGENCE
SDA/LARS™ final report: Development and verification of a learning and recognition system (LARStrademark) for seismic data analysis (SDA), 15:33001 (R;US)
Skolem functions and equality in automated deduction, 15:33841 (R;US)

ASBESTOS
NIOSH (National Institute for Occupational Safety and Health) testimony on asbestos by R. A. Lemen on March 21, 1984, 15:33237 (R;US)

ASCORBIC ACID
[Hydroxyproline-rich glycoproteins of the plant cell wall]: Progress report, June 1989–June 1990, 15:33193 (R;US)

ASDEX TOKAMAK
An optical scanning system for spectroscopic impurity flux investigations inside the ASDEX tokamak, 15:33760 (R;DE)
Sputtering flux measurements in the ASDEX divertor, 15:33818 (R;DE)

ASHES
See also FLY ASH
The removal and control of trace elements in coal and coal wastes, 15:32093 (RA;US)
[A small-scale study of Rocky Flats uncalcined incinerator ash dissolution and filtrate anion exchange]: Draft, 15:32234 (R;US)

ASIA
See also CHINA
JAPAN
PAKISTAN
Anthropogenic sulfur dioxide emission in Far East Asia, 15:32098 (R;JP;In Japanese)

ATF TORSATRON
A portable and independent edge fluctuation diagnostic: Technical progress report, September 14, 1989–May 14, 1990, 15:33736 (R;US)
The effects of chromium and titanium gettering on the operation of the Advanced Toroidal Facility, 15:33806 (R;US)

ATOM-MOLECULE COLLISIONS
Time-dependent treatment of scattering: Integral equation approaches using the time-dependent amplitude density, 15:33385 (J;US)
ATOMIC BEAMS
Sources of spin-polarized beams (invited), 15:32958 (J;US)
ATOMIC BOMBS
See NUCLEAR WEAPONS
ATOMIC CLOUDS
See RADIOACTIVE CLOUDS
ATOMIC EXPLOSIONS
See NUCLEAR EXPLOSIONS
ATOMIC FLUORESCENCE SPECTROSCOPY
See FLUORESCENCE SPECTROSCOPY
ATOMIC IONS
Atomic-scale modeling of low-energy ion-solid processes, 15:33342 (BA;US)
ATOMIC SHELLS
See ELECTRONIC STRUCTURE
ATOMIC WEAPONS
See NUCLEAR WEAPONS
ATOMS
See also MUONIC ATOMS
Atoms in strong, oscillating electric fields: momentum-space solutions of the time-dependent, three-dimensional Schroedinger equation, 15:33357 (J;US)
Exact results on light scattered from atoms pumped by coherent and chaotic fields of arbitrary bandwidth, 15:33382 (J;US)
Laser effects in photoionization: numerical solution of coupled equations for a three-dimensional Coulomb potential, 15:33356 (J;US)
Testing of laser-dressed atomic states, 15:33351 (J;US)
The many faces of resonances in multiphoton ionization, 15:33348 (J;US)
Variable time-step integrator for intense field dynamics, 15:33359 (J;US)
ATR REACTOR
Replacement of core components in the Advanced Test Reactor, 15:32350 (R;US)
Replacement of the Advanced Test Reactor control room, 15:32351 (R;US)
AUFWUCHS
Evaluating direct toxicity and food-chain effects in aquatic systems using natural periphyton communities, 15:33139 (R;US)
AUSTRALITES
See TEKTITES
AUTOMATION
DOE requirements for the next generation controller, 15:33038 (R;US)
AUTOMOBILE EFFICIENCY STANDARDS
See STANDARDS
AUXILIARY WATER SYSTEMS
Aging assessment of auxiliary feedwater systems, 15:32411 (RA;US)

B

B MESONS
See also B MINUS MESONS
B NEUTRAL MESONS
B PLUS MESONS
Influence of the B^* resonance on $\bar{B}\to\pi e\bar{\nu}_e$, 15:33455 (J;US)
Radiative corrections and semileptonic B decays, 15:33471 (J;US)
B MINUS MESONS
Upper limits on $D^\pm$ and $B^\pm$ decays to two leptons plus $\pi^\pm$ or $K^\pm$, 15:33419 (J;US)
B NEUTRAL MESONS
Measurement of the B^0-meson lifetime, 15:33416 (J;US)
Standard-model predictions for CP violation in B^0-meson decay, 15:33481 (J;US)
B PLUS MESONS
Upper limits on $D^\pm$ and $B^\pm$ decays to two leptons plus $\pi^\pm$ or $K^\pm$, 15:33419 (J;US)
BACTERIA
See also ESCHERICHIA COLI
PSEUDOMONAS
STREPTOCOCCUS
Genetic approach to microbial coal desulfurization, 15:32056 (RA;US)
Hydrogen/sulfur metabolism in the hyperthermophilic archaebacterium Pyrodictium brockii: Progress report, March 1, 1989–February 28, 1990, 15:33211 (R;US)
BAG MODEL
Comments on "Neutron-proton mass difference in the chiral solitonic bag model", 15:33584 (J;US)
Mini-inflation prior to the cosmic confinement transition, 15:33296 (R;HU)
The good, the bad, and the baryon, 15:33450 (R;DK)
BALLISTIC MISSILE DEFENSE
Brilliant pebbles, 15:33044 (R;US)
Exchange ratios for singlet boost-phase defenders, 15:33040 (R;US)
Strategic Defense Initiative Organization. Directive, 15:32527 (R;US)
BAND THEORY
How to interpret the validity of the single band model?, 15:33620 (R;XA)
BANKS
See COMMERCIAL BUILDINGS
BARIUM
Autoionization rates for selected double-Rydberg states of barium, 15:33376 (J;US)
Dynamical information for Fe doped $YBa_2Cu_3O_7$ superconducting oxides obtained from high temperature Moessbauer studies, 15:32602 (R;BR)
Electron spectroscopic investigation of atomic 4d giant resonances for Ba, La and lanthanides, 15:33331 (R;DE;In German)
Experimental equations of state for calcium, strontium, and barium metals to 20 kbar from 4 to 295 K, 15:32593 (J;US)
BARIUM 140
Interacting-boson-fermion-fermion model description of $^{140}La_{83}$ and comparison with levels populated by beta decay and neutron capture, 15:33547 (J;US)
BARIUM CARBONATES
High T_c oxide solid state reaction kinetics via complex impedance spectroscopy, 15:32802 (R;US)
BARIUM COMPOUNDS
See also BARIUM CARBONATES
BARIUM OXIDES
The effect of charge mixture ratio and particle size on igniter plume heat transfer characteristics, 15:32871 (R;US)
BARIUM OXIDES
Antiferromagnetism
Magnetic order of the Cu planes and chains in $RBa_2Cu_3O_{6+x}$, 15:32685 (J;US)
Magnetic ordering in $(Y_{1-x}Pr_x)Ba_2Cu_3O_7$ as observed by muon-spin relaxation, 15:32693 (J;US)
Critical Field
Temperature dependence of the lower critical field of single crystal $YBa_2Cu_3O_{7-gd}$, 15:32655 (BA;US)
Crystal Defects
Protons and lattice defects in perovskite-related oxides: Progress report, July 1, 1989–April 30, 1990, 15:32611 (R;US)
Crystal-Phase Transformations
Structural and superconducting properties of oxygen-deficient $NdBa_2Cu_3O_{7-\delta}$, 15:32688 (J;US)
Electronic Structure
$BaBiO_3$ and the effect of potassium substitution using photoemission, 15:32684 (J;US)
Energy Beam Deposition
YBCO films on YSZ and Al_2O_3 by pulsed laser deposition, 15:32631 (BA;US)

Holes
O 2*p* holes: Temperature effects and surface characteristics of cuprate superconductors, 15:32689 (J;US)
Josephson Effect
Interlayer coupling in high temperature superconductors, 15:32647 (BA;US)
Light Transmission
Infrared synchrotron-radiation transmission measurements on $YBa_2Cu_3O_{7-\delta}$ in the gap and supercurrent regions, 15:32691 (J;US)
Magnetic Flux
Observation of thermally activated flux motion inweak link structures, 15:32656 (BA;US)
Magnetoresistance
Flux-flow resistivity in single crystal $YBa_2Cu_3O_{7-\delta}$, 15:32654 (BA;US)
Nmr Spectra
17_{ONMR} study of $YBaa_2Cu_3O_{7-\delta}$, 15:32658 (BA;US)
Nuclear Quadrupole Resonance
Calculation of the nuclear quadrupole resonance spectra of $YBa_2Cu_3O_{7-x}$, 15:32640 (BA;US)
Order Parameters
Ordering in $Tl_2CaBa_2Cu_2O_8$ and $Tl_2Ba_2CuO_6$ studied by pair distribution function and Rietveld analysis, 15:32630 (BA;US)
Phase Diagrams
Structural phase diagram of the $Ba_{1-x}K_xBiO_3$ system, 15:32687 (J;US)
Physical Properties
Calcium-substituted Y-Ba-Cu-O superconductors with enhanced T_c synthesized at elevated oxygen pressures, 15:32686 (J;US)
Superconducting thin films of YBaCu oxides prepared by MOCVD, 15:32607 (R;US)
Sintering
Rapid thermal processing of high temperature superconducting fiber, 15:32616 (R;US)
Specific Heat
Effect of Cu^{2+} magnetic moments on the superconductivity of $YBa_2Cu_3O_7$: The origin of the "linear term" in the specific heat; The volume fraction of superconductivity, 15:32613 (R;US)
Stacking Faults
Effects of deformation on shielding currents in $YBa_2Cu_3O_{7-\delta}$, 15:32650 (BA;US)
Superconducting Films
Hall effect mesurements in thin films of $Tl_2Ba_2CaCu_2O_x$, 15:32661 (BA;US)
Surface resistance of $YBa_2Cu_3O_7$ films deposited on $LaGaO_3$ substrates, 15:32900 (BA;US)
Superconductivity
Effect of electron and volume change via SB (V) doping on the superconducting behavior of $K_{0.14}Ba_{0.6}Bi_{1-x}Sb_xO_3$, 15:32625 (BA;US)
Evidence for a charge-density wave or spin-density wave in the Cu-O chains in $YBa_2Cu_3O_{7-x}$, 15:32678 (J;US)
Magnetic order of the Cu planes and chains in $RBa_2Cu_3O_{6+x}$, 15:32685 (J;US)
Preparation and characterization of single phase $Ba_{1-x3}K_xBiO_3$, 15:32651 (BA;US)
Processing chemically prepared $YBa_2Cu_3O_7$ precursor powders, 15:32898 (BA;US)
Structural and superconducting properties of oxygen-deficient $NdBa_2Cu_3O_{7-\delta}$, 15:32688 (J;US)
Superconducting properties of grain boundaries in dense, fine grained $YBa_2Cu_3O_x$, 15:32660 (BA;US)
Superconductors
The production of high performance $YBa_2Cu_3O_7$ using nitrogen dioxide, 15:32666 (J;US)
Transition Temperature
Magnetic and pairing correlations in a three band Hubbard model, 15:32646 (BA;US)

BARYON NUMBER
Physical properties of the chiral quantum baryon, 15:33429 (R;BR)

BARYON RESONANCES
See BARYONS

BARYONS
See also NUCLEONS
Baryon-symmetric baryogenesis, 15:33512 (J;US)
Nonperturbative self-consistent unitary loop corrections to Skyrmion masses, 15:33526 (J;US)
Observed supersymmetry in baryon and meson spectra with IBFM, the interacting boson fermion model, 15:33441 (R;BR)
The good, the bad, and the baryon, 15:33450 (R;DK)

BCC LATTICES
Ion-beam mixing in amorphous and crystalline Fe-Ti, 15:32568 (BA;US)

BEAM BENDING MAGNETS
SSRL-PEP ring divertor channel entrance thermal stress analysis for new bending magnet loads, 15:32961 (R;US)

BEAM DYNAMICS
Orbit calculations and lattice parameters for the BNL [Brookhaven National Laboratory] SXLS [Superconducting X-Ray Lithography Source]: Part 2, Betatron functions in the superconducting bending magnet and synchrotron radiation integrals, 15:32920 (R;US)

BEAM EMITTANCE
Optical Cherenkov measurements of emittance growth in the Advanced Test Accelerator beam under laser ion-guiding, 15:32946 (BA;US)

BEAM FOCUSING MAGNETS
A colloidal solution of Fe_3O_4 crystallites to optically locate the magnetic center of multipole magnets, 15:32934 (R;JP)

BEAM INJECTION
See also RELATIVISTIC BEAM INJECTION
Induction linac energy regulation via injector current modulation, 15:32940 (R;US)
Operating experience with the Argonne PIIECR ion source system, 15:32928 (J;US)

BEAM INJECTION HEATING
Model of collisional and radiative processes in REBEX plasma, 15:33744 (RA;CS)
Time development of profile of H_α line in REBEX plasma, 15:33745 (RA;CS)
Time resolved diagnostics of hot plasma radiation by Si surface barrier detectors, 15:33747 (RA;CS)

BEAM OPTICS
Interactive beam tuning simulator for the SLC Final Focus, 15:32927 (BA;US)

BEAM PERVEANCE
See BEAM EMITTANCE

BEAM POSITION
Beam position monitors for the CESR linac, 15:32962 (BA;US)

BEAM PROFILES
Optical Cherenkov measurements of emittance growth in the Advanced Test Accelerator beam under laser ion-guiding, 15:32946 (BA;US)

BEAM TRANSPORT
Advanced methods for the computation of particle beam transport and the computation of electromagnetic fields and beam-cavity interactions: Annual report, 15:32922 (R;US)

BEAM WIDTHS
See BEAM PROFILES

BEAM-PLASMA SYSTEMS
15th Czechoslovak seminar on plasma physics and technology. Part 2, 15:33722 (R;CS;In English, Russian)
Electron acoustic and magnetoacoustic modes in a magnetized beam plasma system, 15:33739 (R;XA)
Model of collisional and radiative processes in REBEX plasma, 15:33744 (RA;CS)
Plasma compensation effects with relativistic electron beams, 15:32917 (BA;US)
Some results of diamagnetic measurements on Rebex machine, 15:33743 (RA;CS)

BEARINGS
Characterization of high damping bearings and their responses to earthquake motions, 15:32842 (R;US)

BEAUTY PARTICLES
Prompt leptons from the decays of heavy quarks in the e^+e^- annihilation at energies of 35 and 43 GeV, 15:33408 (R;DE;In German)
BEDT-TTF
Importance of weak hydrogen bonding C-H–donor and C-H–anion interactions in governing the structural properties of organic donors BEDT-TTF and BEDO-TTF and their charge-transfer salts, 15:32803 (R;US)
BELGIUM
Public perception and acceptance of the siting of nuclear waste facilities in seven countries, 15:32218 (R;US)
BENTHOS
Long-term benthic monitoring studies in the freshwater portion of the Potomac River: 1983 to 1985, cumulative report. Volume 2. Appendices, 15:33144 (R;US)
Long-term benthic monitoring studies in the freshwater portion of the Potomac River: 1983 to 1985, cumulative report. Volume 1. Text, 15:33143 (R;US)
BENZENE
Modification of coal surfaces with methyl radicals, 15:32057 (RA;US)
Molecular beam studies of the photodissociation of benzene at 193 and 248 nm, 15:32828 (J;US)
BENZYL RADICALS
Gas-phase heats of formation of $C_7H_7^+$ isomers: M-tolyl, p-tolyl, and benzyl ions, 15:32822 (J;US)
BERYL
Decay kinetics study of atomic hydrogen in a-Si:(H,O,N) and natural beryl, 15:33335 (R;BR)
BERYLLIUM
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 7. Primary beryllium, primary nickel and cobalt, secondary nickel, secondary tin. Final report, 15:33160 (R;US)
Experiments on tritium behavior in beryllium, (2): Tritium released by recoil and diffusion, 15:32547 (R;JP;In Japanese)
A dependence of highly inelastic *p*-nucleus collisions, 15:33418 (J;US)
BERYLLIUM 10
^{10}Be profiles in lunar surface rock 68815, 15:33316 (BA;US)
BERYLLIUM ALLOYS
See also HAVAR
The low-temperature phase diagram of $U_{2-x}Th_xBe_{13}$, 15:32581 (BA;US)
BERYLLIUM MODERATORS
See BERYLLIUM
BESSEL DIFFERENTIAL EQUATION
See FOKKER-PLANCK EQUATION
BETA BACKSCATTERING GAGES
See RADIOMETRIC GAGES
BETA BEAMS (ELECTRONS)
See ELECTRON BEAMS
BETA BEAMS (POSITRONS)
See POSITRON BEAMS
BETA-PLUS DECAY
Observation of the delayed proton decay by means of a recoil mass separator, 15:33405 (RA;JP;In Japanese)
BF3 COUNTERS
Some factors affecting the accuracy of uranium content determined by DNC measurement, 15:32970 (R;CN;In Chinese)
BILLITONITES
See TEKTITES
BINARY STARS
Recent progress in understanding the eruptions of classical novae, 15:33300 (R;US)
BINDERS
Binder with base of aqueous solution of alkaline silicates, how to obtain it and its applications, 15:32704 (TG;US)
BIOGAS
See METHANE
BIOLOGICAL REACTORS
See BIOREACTORS
BIOLOGICAL REPAIR
Investigations on the detection and prevention of DNA-lesions induced by ionizing irradiation, 15:33220 (R;DE;In German)
BIOLOGICAL STRESS
Progeny test of Norway Spruce stands in the Black Forest (areas of origin 840 08 and 840 09) aiming at: 1. Improvement of immission tolerance. 2. Conservation of genetic resources of damaged stands in high altitudes ('Gene Bank'), 15:33233 (R;DE;In German)
BIOMASS
Biomass and hydrocarb technology for removal of atmospheric CO_2, 15:32266 (R;US)
BIOREACTORS
Reactors for scaling-up coal bioprocessing, 15:32067 (R;US)
BIOSPHERE
[Finalization of the International Biospheric Model Validation Study]: Foreign trip report, April 22, 1990–April 28, 1990, 15:33067 (R;US)
BIOTECHNOLOGY
NIST (National Institute of Standards and Technology) research reports, January 1990. Special pub, 15:33631 (R;US)
BIPHENYL
High-performance liquid chromatographic assay of biphenyl metabolism by hepatocytes cultured in an embryo/hepatocyte co-culture medium, 15:33247 (R;US)
BISETHYLENEDITHIOLOTETRATHIAFULVALENE
See BEDT-TTF
BISMUTH OXIDES
$BaBiO_3$ and the effect of potassium substitution using photoemission, 15:32684 (J;US)
Chemistry and superconducting behavior of Sb-substituted Bi/Pb-based oxides, 15:32626 (BA;US)
Effect of electron and volume change via SB (V) doping on the superconducting behavior of $K_{0.14}Ba_{0.6}Bi_{1-x}Sb_xO_3$, 15:32625 (BA;US)
Electronic structure and optical properties of LiB_3O_5, 15:32696 (J;US)
In-situ growth of superconducting films of Bi-Sr-Ca-Cu-O using magnetron sputtering, 15:32604 (R;US)
Interlayer coupling in high temperature superconductors, 15:32647 (BA;US)
O 2*p* holes: Temperature effects and surface characteristics of cuprate superconductors, 15:32689 (J;US)
Preparation and characterization of single phase $Ba_{1-x3}K_xBiO_3$, 15:32651 (BA;US)
Structural phase diagram of the $Ba_{1-x}K_xBiO_3$ system, 15:32687 (J;US)
BITTER SPAR
See DOLOMITE
BITUMENS
Microbial degradation of bitumen, 15:32706 (R;CH;In German)
BITUMINOUS COAL
Coal-water interactions and preparation of dewatered ultrafine clean coal, 15:32038 (RA;US)
Electroosmotically enhanced dewatering/deliquoring of fine particle coal, 15:32039 (RA;US)
Simultaneous SO_x/NO_x control: Technical report, April 1, 1987–March 31, 1988 including Quarterly technical progress report, January–March 1988, 15:32310 (R;US)
BLACK HOLES
Information loss down a black hole, 15:33293 (R;XA)
BLADES (TURBINES)
See TURBINE BLADES
BLANKETS (BREEDING)
See BREEDING BLANKETS
BLAST FURNACES
Effect of blast furnace coal injection upon bosh coke properties, coke combustion and furnace permeability, 15:32117 (R;XE)
BLASTS
See EXPLOSIONS
BLENDING
See MIXING

BLOOD
Investigation of effects of 60-Hz electric and magnetic fields on operant and social behavior and on the neuroendocrine system of nonhuman primates: Annual report, 15:32435 (R;US)

BLOWDOWN
Assessment of TRAC-PF1/MOD1 Version 14.3 using separate effects critical flow and blowdown experiments: Volume 2, Figures, 15:32424 (R;US)
Assessment of TRAC-PF1/MOD1 version 14.3 using separate effects critical flow and blowdown experiments: Volume 1, Test and tables, 15:32423 (R;US)

BNL
Nuclear engineering research opportunities at Brookhaven National Laboratories, 15:32462 (R;US)

BODY CENTERED CUBIC
See BCC LATTICES

BODY WAVES P (SEISMIC)
See SEISMIC P WAVES

BODY WAVES S (SEISMIC)
See SEISMIC S WAVES

BOILER FUEL
See BOILER FUELS

BOILER FUELS
Poly aromatic hydrocarbons in flue gas from straw-fueled boilers: Pilot investigation, 15:32271 (R;DK;In Danish)

BOILERS
Three-stage combustion (reburning) on a full-scale operating boiler in the USSR. Final report, March 1988-January 1990, 15:32316 (R;US)

BOILING WATER COOLED AND MODERATED REACTOR
See BWR TYPE REACTORS

BOLOMETERS
Fabrication of a high T_c superconducting bolometer, 15:32989 (R;US)

BOREHOLES
A comparison of analytical approaches for wellbore heat transmission in layered formations, 15:33261 (R;US)
Borehole sealing: conceptual design and feasibility study, 15:32226 (R;CH;In German)
Chemistry of waters in the Boettstein, Weiach, Riniken, Schafisheim, Kaisten and Leuggern boreholes: a hydrochemically consistent data set, 15:33266 (R;CH)
Electric logging and electrical properties of rocks in Rainier Mesa area, Nevada Test Site, Nevada, 15:32717 (R;US)
Exploratory borehole Leuggern: constructional and environmental aspects, drilling technique, 15:33265 (R;CH;In German)
Exploratory borehole Leuggern: geology: Appendix volume, 15:33263 (R;CH;In German)
Exploratory borehole Leuggern: geology: Text volume, 15:33264 (R;CH;In German)
Exploratory borehole Weiach: investigation report: Appendix volume, 15:33272 (R;CH;In German)
Exploratory borehole Weiach: investigation report: Text volume, 15:33273 (R;CH;In German)
Interpretation of hydraulic testing at the Weiach borehole, 15:33270 (R;CH)
Interpretation of hydraulic testing in crystalline rock at the Leuggern borehole, 15:33269 (R;CH)
Interpretation of hydraulic testing in the sediments of the Riniken borehole, 15:33268 (R;CH)
Oberbauenstock (OBS) 1987: results of the hydrogeological testing program OBS-1, 15:33271 (R;CH)

BORIC ACID
Special Wasteform Lysimeter Program wasteform characteristics, 15:32214 (R;US)

BORON
Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the Salton Sea Area, California, 1986-87. Water-Resources investigation, 15:33164 (R;US)

BORON 10
Search for radiative transitions in the hypernucleus $_{\Lambda}{}^{10}B$, 15:33533 (J;US)

BORON ADDITIONS
Effect of aluminum level on boron clustering in Ni_3Al, 15:32560 (BA;US)

BOSONS
See also MESONS
Hadron-collider limits on new electroweak interactions from the heterotic string, 15:33454 (J;US)
Non-linear σ-models and string theories, 15:33511 (BA;US)
On BRST quantization of chiral bosonic particle, 15:33661 (R;BR)
Symplectic bosons, Fermi fields and super Jordan algebras, 15:33702 (R;BR)

BOTTOM PARTICLES
See BEAUTY PARTICLES

BOUNDARY LAYERS
Plasma turbulence, 15:33832 (J;US)

BRAIN
PBF/BNCT [Power Burst Facility/Boron Neutron Capture Therapy] Program for Cancer Treatment: Monthly bulletin, Volume 4, No. 3, 15:33222 (R;US)

BRAKING RADIATION
See BREMSSTRAHLUNG

BREEDING BLANKETS
The measurement of gamma heating in a fusion blanket test assembly, 15:33804 (R;US)

BREMSSTRAHLUNG
Development of high-power X-ray generation target for radiation processing, 15:32933 (R;JP;In Japanese)

BRIDGES (ELECTRIC)
See ELECTRIC BRIDGES

BRONCHOGENIC CARCINOMA
See CARCINOMAS

BROOKHAVEN AGS
Applications of modern filtering to accelerators, 15:32913 (BA;US)

BROOKHAVEN NATIONAL LABORATORY
See BNL

BROOKHAVEN RHIC
New challenges for HEP computing: RHIC [Relativistic Heavy Ion Collider] and CEBAF [Continuous Electron Beam Accelerator Facility], 15:32906 (R;US)

BUDGETS
Guide for technical analysis of budget proposals for financial assistance, 15:33837 (R;US)

BUILDING (CONSTRUCTING)
See CONSTRUCTION

BUILDINGS
See also ANIMAL SHELTERS
COMMERCIAL BUILDINGS
CONTAINMENT BUILDINGS
GREENHOUSES
HOSPITALS
OFFICE BUILDINGS
RESIDENTIAL BUILDINGS
Characterization of high damping bearings and their responses to earthquake motions, 15:32842 (R;US)
Energy conservation program evaluation: Practical methods, useful results: Proceedings: Volume 2, August 20 and 21 sessions, 15:32479 (R;US)
Insulating coatings (excluding electrical insulation). January 1980-November 1989 (A Bibliography from World Surface Coatings Abstracts). Report for January 1980-November 1989, 15:32487 (R;US)
Passive cooling, 15:32483 (B;US)

BUILDINGS (CONTAINMENT)
See CONTAINMENT BUILDINGS

BUNDLES (FUEL ELEMENTS)
See FUEL ELEMENT CLUSTERS

BURNOUT
Effect of rib on burnout heat flux, 15:32339 (R;US)

BURNUP
Mass spectrometric measuring of nuclear fuel burnup, 15:32779 (R;CN;In Chinese)

BUSES
Transportation plan for the shuttle bus: Saco-Biddeford-Old Orchard Beach, 15:32494 (R;US)

BWR TYPE REACTORS
See also ENEL-4 REACTOR
GRAND GULF-1 REACTOR
JPDR REACTOR
A model for a recovery of a badly degraded core, 15:32361 (R;US)
Containment long-term operational integrity–a 1988 status report, 15:32377 (RA;US)
Development of a hydrogen mitigation strategy for degraded core accidents in a BWR/6 - Mark III power plant, 15:32385 (RA;US)
Environmentally assisted cracking in light water reactors, 15:32552 (RA;US)
Experimental study for structural behavior of reinforced concrete containment vessel beyond design pressure, 15:32390 (RA;US)
Fission product release as a function of chemistry and fuel morphology, 15:32345 (R;US)
Mechanical damage experience in major light water reactor systems, 15:32364 (R;US)
Nuclear power applications of NASA control and diagnostics technology: Volume 1, Project results: Final report, 15:32341 (R;US)
Preliminary observations of upcoming Phase II gate valve flow interruption tests, 15:32408 (RA;US)
Proposed acceptance criteria for severe accident evaluations of steel containment vessels, 15:32380 (RA;US)
Reactivity accidents: A reassessment of the design-basis events, 15:32402 (RA;US)
Recriticality in a boiling water reactor following a core damage accident, 15:32404 (RA;US)
Thermal behavior of cohesive debris beds in a degraded nuclear reactor, 15:32319 (R;US)
Value-impact analysis of regulatory options for resolution of Generic Issue C-8: MSIV [Main Steam Isolation Valve] leakage and LCS [Leakage Control System] failure, 15:32419 (R;US)

BY-PRODUCTS
Mild gasification liquid characterization data for sytems modeling and assesment, 15:32080 (BA;US)
Production of jet fuel from coal-derived liquids: Report No. 16: Quarterly technical progress report, second quarter FY 1988, January 1, 1988–March 31, 1988, 15:32061 (R;US)

C

C CODES
CRUSH: a simplified computer program for impact analysis of radioactive material transport casks, 15:33846 (R;JP)

C-1430 RESONANCES
See MESONS

CADMIUM
Cadmium exposure: Toxicity in humans. April 1978-November 1989 (A Bibliography from the Life Sciences Collection data base). Report for April 1978-November 1989, 15:33253 (R;US)
Comparison of age-related changes in in vivo and in vitro measures of testicular steroidogenesis after acute cadmium exposure in the sprague-dawley rat, 15:33249 (R;US)
Concentrations of metals in Norton Sound seawater samples and human hair samples, 1989, 15:33188 (R;US)
National Performance Audit Program: Acid rain audits, 1988, 15:33082 (R;US)

CADMIUM TELLURIDES
Band-gap narrowing in ordered and disordered semiconductor alloys, 15:32750 (J;US)
Interfacial chemistry of metals on CdTe and ZnTe (110), 15:32757 (J;US)
The growth of high quality CdTe on GaAs by molecular beam epitaxy, 15:32754 (J;US)

CAFETERIAS
See RESTAURANTS

CALCITE
Radiation-induced paramagnetic species in natural calcite speleothems, 15:33612 (R;BR)

CALCIUM
Experimental equations of state for calcium, strontium, and barium metals to 20 kbar from 4 to 295 K, 15:32593 (J;US)

CALCIUM 40 REACTIONS
High-spin structure of N=51 ^{96}Rh and ^{97}Pd: A shell-model study, 15:33548 (J;US)

CALCIUM 40 TARGET
Observation of double isovector giant dipole resonances from pion double charge exchange, 15:33535 (J;US)

CALCIUM FLUORIDES
Chemical bonding and lattice mismatch in semiconductor-insulator heteroepitaxy: SrFsub 2on Si(111), 15:32736 (BA;US)

CALCIUM OXIDES
Chemistry and superconducting behavior of Sb-substituted Bi/Pb-based oxides, 15:32626 (BA;US)
Hall effect mesurements in thin films of $Tl_2Ba_2CaCu_2O_x$, 15:32661 (BA;US)
In-situ growth of superconducting films of Bi-Sr-Ca-Cu-O using magnetron sputtering, 15:32604 (R;US)
Interlayer coupling in high temperature superconductors, 15:32647 (BA;US)
O 2p holes: Temperature effects and surface characteristics of cuprate superconductors, 15:32689 (J;US)
Ordering in $Tl_2CaBa_2Cu_2O_8$ and $Tl_2Ba_2CuO_6$ studied by pair distribution function and Rietveld analysis, 15:32630 (BA;US)
Simultaneous NO_x/SO_2 removal with dry sorbent injection, 15:32314 (RA;US)

CALCULATIONS (3-DIMENSIONAL)
See THREE-DIMENSIONAL CALCULATIONS

CALIBRATION STANDARDS
Long-term stability of solid standards for radiochemical analysis, 15:32785 (R;US)

CALIFORNIA
See also LOS ANGELES
Ambient concentrations of PCDDs/PCDFs (polychlorinated dibenzodioxins/dibenzofurans) in the South Coast Air Basin. Final report, 1987-1990, 15:33068 (R;US)
Superfund Record of Decision (EPA Region 9): Purity Oil Sales, CA. (First remedial action), September 1989, 15:32158 (R;US)

CALIFORNIUM
Separation of californium from actinides and lanthanides in aqueous solution by electrochemical formation of amalgams, 15:32787 (R;FR)

CALORIMETERS
Behaviour of the ZEUS uranium-scintillator calorimeter for low-energetic particles with energies of 0.2 - 10.0 GeV, 15:32972 (R;DE;In German)
Development of a precise hadron calorimeter, 15:32971 (R;DE;In German)

CALORIMETERS (PARTICLE)
See SHOWER COUNTERS

CAM
See COMPUTER-AIDED MANUFACTURING

CAMERAS
See also GAMMA CAMERAS
STREAK CAMERAS
TELEVISION CAMERAS
Holographic measurement of ejecta from shocked metal surfaces, 15:32874 (BA;US)
Time-resolved solid-state array imaging system: Developments and applications, 15:32261 (BA;US)

CANADA
See also ONTARIO
Energy requirements in Canadian restaurants: Final report, 15:32485 (R;CA)
Major chemical accidents: Are we prepared?, 15:32443 (R;CA)
Renewable energy research and development workshop, 15:32472 (R;CA)

CANCER
See NEOPLASMS

CANISTERS
See CONTAINERS
CANONICAL EQUATIONS
See DIFFERENTIAL EQUATIONS
CANONICAL QUANTUM FIELD THEORY
See LAGRANGIAN FIELD THEORY
CAORSO REACTOR
See ENEL-4 REACTOR
CAPACITORS
Total-dose degradation of thin film ferroelectric capacitors, 15:32986 (R;US)
CARBAMIDE
See UREA
CARBINOL
See METHANOL
CARBON
See also DIAMONDS
GRAPHITE
Formation of hydrogenated amorphous carbon films of controlled hardness from a methane plasma, 15:32770 (J;US)
High resolution electron microscopy study of as-prepared and annealed tungsten-carbon multilayers, 15:32579 (BA;US)
On the structure of carbon films deposited on Si(111) by mass-selected low energy C^+ beams, 15:32718 (BA;US)
Transient group combustion: Steady state simulation and transient results, 15:32119 (BA;US)
A dependence of highly inelastic *p*-nucleus collisions, 15:33418 (J;US)
A dependence of J/ψ production in π^--nucleus collisions at 530 GeV/*c*, 15:33411 (J;US)
CARBON 12 TARGET
Parity violating weak neutral current effects in elastic e-^{12}C scattering: Final report, August 15, 1987–May 14, 1989, 15:33530 (R;US)
CARBON 13 REACTIONS
Nuclear Landau-Zener promotion in the reactions of the system $^{13}C + {}^{16}O \rightarrow {}^{12}C + {}^{17}O$, 15:33531 (R;JP)
CARBON 14
Radionuclide uptake by pinetrees growing on lysimeters, 15:33123 (R;US)
CARBON DIOXIDE
A critical appraisal of model simulations, 15:33107 (R;US)
Biomass and hydrocarb technology for removal of atmospheric CO_2, 15:32266 (R;US)
CO_2 emissions from production and combustion of fuel ethanol from corn, 15:32270 (R;US)
Crossover from singular critical to regular classical thermodynamic behavior of fluids, 15:33396 (J;US)
Diesels in the occupational environment: An environmental perspective, 15:33073 (R;US)
Multi-dimensional aspects of recent climate change in North America: Progress report, August 15, 1989–April 1, 1990, 15:33054 (R;US)
Policy options for stabilizing global climate. Draft report to congress. Executive Summary. Draft report, 15:33079 (R;US)
Results of emissions and ash testing in full-scale co-combustion tests of binder-enhanced dRDF pellets and high-sulfur coal, 15:32513 (R;US)
CARBON DIOXIDE LASERS
Engineering aspects of long pulse, CO_2 lasers employing plasma discharge electrodes, 15:32893 (BA;US)
Preionization techniques for discharge lasers, 15:32889 (BA;US)
Pulse power considerations for the generation of 45 μs, 200 keV electron beams for CO_2 lasers, 15:33827 (BA;US)
CARBON IONS
Charge-transfer reactions of ground-state $C^+(^2P)$ and metastable-state $C^+(^4P)$ ions with H_2 molecules, 15:33371 (J;US)
Phases and microstructures of carbon-implanted niobium, 15:32645 (BA;US)
CARBON MONOXIDE
Carbon monoxide toxicity. April 1978-November 1989 (A Bibliography from the Life Sciences Collection data base). Report for April 1978-November 1989, 15:33254 (R;US)
Diesels in the occupational environment: An environmental perspective, 15:33073 (R;US)
Relationship between CO, POHC, and pic emissions from a simulated hazardous waste incinerator, 15:33086 (R;US)
CARBON STEELS
Decontamination impacts on solidification and waste disposal, 15:32200 (R;US)
CARBONATES
See also BARIUM CARBONATES
Oil shale quarterly report, April–December 1989, 15:32186 (R;US)
CARBONYLS
Southern California Air Quality Study (SCAQS) description of measurement activities. Final report, 15:33093 (R;US)
CARCINOGENESIS
Chronobiological effects of electric fields, 15:33260 (BA;US)
v-src induces clonal sarcomas and rapid metastasis following transduction with a replication-defective retrovirus, 15:33207 (J;US)
CARCINOGENS
Lawrence Livermore National Laboratory RCRA Part B health risk assessment: Phase 2, Hazardous waste management units: Appendices, 15:33230 (R;US)
Proposed national strategies for the prevention of leading work-related diseases and injuries: Occupational cancers, 15:33245 (R;US)
Workshop report on EPA (Environmental Protection Agency) guidelines for carcinogen risk assessment: Use of human evidence. Held in Washington, DC. on June 26-27, 1989, 15:33246 (R;US)
CARCINOMAS
Assessing inhalation risks from the land treatment of petroleum refining wastes, 15:32151 (B;US)
Extremely low frequency electromagnetic fields: The question of cancer, 15:33259 (B;US)
CARS SPECTROSCOPY
See RAMAN SPECTROSCOPY
CASCADE (EXTRACTION)
See EXTRACTION COLUMNS
CASIMIR EFFECT
Casimir effect in a d-dimensional flat spacetime and the cut-off method, 15:33665 (R;BR)
CASIMIR OPERATORS
The combinatorics computation for Casimir operators of the symplectic Lie algebra and the application for determining the center of the enveloping algebra of a semidirect product, 15:33686 (R;XA)
CASKS
See also SPENT FUEL CASKS
CRUSH: a simplified computer program for impact analysis of radioactive material transport casks, 15:33846 (R;JP)
CASTOR TOKAMAK
15th Czechoslovak seminar on plasma physics and technology. Part 2, 15:33722 (R;CS;In English, Russian)
A model for the electrostatic turbulence observed in the Castor tokamak, 15:33752 (RA;CS)
Control of plasma position on the Castor tokamak, 15:33750 (RA;CS)
Edge density profile studies in the Castor tokamak using a thermal lithium beam, 15:33756 (RA;CS)
Electrostatic edge turbulence on CASTOR tokamak, 15:33751 (RA;CS)
Particle injection into the Castor tokamak by electric arcs, 15:33753 (RA;CS)
CATHODES
Cathode erosion rates in vacuum-arc discharges–, 15:33831 (J;US)
Physical modeling of bubble phenomena, electrolyte flow and mass transfer in simulated advanced Hall cells: Final report, 15:32504 (R;US)
CAVITY RESONATORS
See also SUPERCONDUCTING CAVITY RESONATORS
Determination of calibration constants for perturbing objects of cavity resonators, 15:32879 (R;BR;In Portuguese)

Structure and RF characteristics of the INS 25.5-MHz split coaxial RFQ, 15:32923 (R;JP)

CEBAF ACCELERATOR
New challenges for HEP computing: RHIC [Relativistic Heavy Ion Collider] and CEBAF [Continuous Electron Beam Accelerator Facility], 15:32906 (R;US)

CELL GROWTH (ANIMAL)
See ANIMAL CELLS

CELLOBIOSE
Hydrolysis of cellobiose by immobilized β-glucosidase entrapped in maintenance-free gel spheres, 15:33215 (R;US)

CELLS (ANIMAL)
See ANIMAL CELLS

CELLS (BACTERIAL)
See BACTERIA

CELLS (ELECTROLYTIC)
See ELECTROLYTIC CELLS

CELLS (REACTOR)
See REACTOR CELLS

CELLULOSE
A new tool for cellulose degradation studies, 15:32732 (BA;US)

CEMENTS
History and some potentials of oil shale cement, 15:32190 (R;US)
Insulating coatings (excluding electrical insulation). January 1980-November 1989 (A Bibliography from World Surface Coatings Abstracts). Report for January 1980-November 1989, 15:32487 (R;US)

CERAMIC MELTERS
West Valley Demonstration Project annual report to Congress, 15:32243 (R;US)

CERAMICS
Acoustical and dynamic mechanical characterization of fiber-matrix interface bonds in ceramic composites, 15:32066 (R;US)
Critical phenomena in nanoscale multilayer materials, 15:32565 (BA;US)
Cyclic damage zones ahead of tensile fatigue cracks in ceramic materials, 15:32608 (R;US)
Energy beam treatment for improved adhesion of coatings to surfaces, 15:32697 (P;US)
Fatigue crack growth in ceramic materials at ambient and elevated temperatures, 15:32610 (R;US)
High-resolution microscopy of ceramics, 15:32634 (BA;US)
Initial studies of electric field effects on ceramic powder formation in flames, 15:32860 (R;US)
Microstructure of nonocrystalline ceramics, 15:32624 (BA;US)
Multicomponent ultrafine microstructures, 15:32617 (B;US)
Polymers, fractals, and ceramic materials, 15:32671 (J;US)
Radiographic imaging technologies for archaeological ceramics, 15:32629 (BA;US)
Synthesis, characterization, and properties of nanophase ceramics, 15:32620 (BA;US)
The influence of thickness and wavelength on the mechanical properties of a compositionally modulated ceramic thin film, 15:32628 (BA;US)

CERIUM
Effects of A1 substitution by Fe in $CeAl_2$, 15:32531 (R;BR)
Electron spectroscopic investigation of atomic 4d giant resonances for Ba, La and lanthanides, 15:33331 (R;DE;In German)

CERIUM OXIDES
Effects of zinc substitution on the electron superconductor $Nd_{1.85}Ce_{0.15}CuO_{4-\delta}$, 15:32692 (J;US)
Magnetic ordering of Nd in $(Nd,Ce)_2CuO_4$, 15:32680 (J;US)
Magnetism, specific heat, and pressure-dependent reistivity of the electron-doped compounds LnMCuO(Ln = Pr,Nd,Sm,Eu,Gd:M = Ce,Th), 15:32641 (BA;US)
Protons and lattice defects in perovskite-related oxides: Progress report, July 1, 1989–April 30, 1990, 15:32611 (R;US)
Superconductivity and magnetic scattering in the $Nd_{2-z}Ce_xCuO_{4-gd}$, 15:32618 (BA;US)
Upper critical field of a $Sm_{1.85}Ce_{0.15}CuO_{4-y}$ single crystal: Interaction between superconductivity and antiferromagnetic order in copper oxides, 15:32670 (J;US)

CESIUM
Core-level photoemission from alkali metals on Ru(001), 15:32594 (J;US)
The ionization of thermal and hyperthermal beams of Na, K, and Cs on Si(111) surfaces, 15:33646 (J;US)

CESIUM 132
Decay of ^{132}Cs and nuclear structure of ^{132}Xe, 15:33541 (R;BR)

CESIUM 134
Examination of the impact of radioactive liquid effluent releases from the Rancho Seco Nuclear Power Plant, 15:33190 (J;US)
Ressac program plants analytical experiments study of a code modelling the soil to plant transfer factor of cesium, 15:33117 (R;FR;In French)

CESIUM 137
An aerial radiological survey of the Evans Area, US Army Communications-Electronics Command, Fort Monmouth, New Jersey: Date of survey, November 1988, 15:33055 (R;US)
An aerial radiological survey of the United States Department of Energy's Rocky Flats Plant, Golden, Colorado: Date of survey, July 1989, 15:33057 (R;US)
Examination of the impact of radioactive liquid effluent releases from the Rancho Seco Nuclear Power Plant, 15:33190 (J;US)
Long-term stability of solid standards for radiochemical analysis, 15:32785 (R;US)
Multicomponent ion-exchange equilibria in chabazite zeolite, 15:32203 (R;US)
Radionuclide uptake by pinetrees growing on lysimeters, 15:33123 (R;US)

CESIUM CHLORIDES
Piezochromism: Pressure-induced isomerizations in the tetrachlorocuprate anion in the solid state with various cations, 15:32592 (J;US)

CESIUM IONS
Experimental determination of a species-dependent effect in the transverse emittances of sputter-generated negative-ion beams, 15:33640 (J;US)
Solid state cesium ion guns for surface studies, 15:33363 (J;US)

CESR STORAGE RING
Beam position monitors for the CESR linac, 15:32962 (BA;US)

CHALKS
See LIMESTONE

CHARCOAL
Activated charcoal. October 1976-December 1989 (A Bibliography from the COMPENDEX data base). Report for October 1976-December 1989, 15:33185 (R;US)

CHARGED PARTICLES
See also DEUTERONS
IONS
Charged-particle multiplicities following pion absorption on ^6Li, 15:33532 (J;US)

CHARGED-PARTICLE ACTIVATION
See CHARGED PARTICLES

CHARGED-PARTICLE TRANSPORT
SIMION PC/PS2 electrostatic lens design program, 15:33361 (J;US)
Stochastic simulation of charged particle transport on the massively parallel processor, 15:33302 (RA;US)

CHARM PARTICLES
See also CHARMED MESONS
Prompt leptons from the decays of heavy quarks in the e^+e^- annihilation at energies of 35 and 43 GeV, 15:33408 (R;DE;In German)

CHARMED MESON RESONANCES
See CHARMED MESONS

CHARMED MESONS
See also D MESONS
D*-2010 MESONS
Nonresonant three-body decays of charmed mesons, 15:33462 (J;US)

CHEMICAL ANALYSIS
See also NONDESTRUCTIVE ANALYSIS
Pantex Plant site environmental report for calendar year 1988, 15:33062 (R;US)

Quality control and the use of reference materials in an environmental laboratory, 15:33011 (BA;US)
Spherical pinch discharges for elemental analysis, 15:32790 (BA;US)
Studies of the analyte-carrier interface in flow injection analysis: Project report, June 1, 1987–December 1, 1989, 15:32784 (R;US)

CHEMICAL EFFLUENTS
Evaluating direct toxicity and food-chain effects in aquatic systems using natural periphyton communities, 15:33139 (R;US)

CHEMICAL EXPLOSIVES
See also NITROMETHANE
SHAPED CHARGES
TATB
Burning mechanism and regression rate of RX-35-AU and RX-35-AV as a function of HMX particle size measured by the hybrid closed bomb-strand burner, 15:33031 (R;US)
Development of a high-tensile-strain plastic-bonded TATB explosive, 15:33030 (R;US)
Explosives detection using an atmospheric sampling glow discharge ionization source with an ion trap mass spectrometer, 15:33023 (BA;US)
Modeling laser ignition of explosives and pyrotechnics: Effects and characterization of radiative transfer, 15:33028 (R;US)
Paste extrudable explosives: Their history and their current status, 15:33032 (R;US)
The search for high energy low vulnerability explosives, 15:33029 (R;US)

CHEMICAL INDUSTRY
Major chemical accidents: Are we prepared?, 15:32443 (R;CA)
Waste processing and pollution in the chemical and petrochemical industries. March 1983-March 1990 (A Bibliography from the NTIS data base). Report for March 1983-March 1990, 15:32150 (R;US)

CHEMICAL REACTORS
A direct absorber reactor/receiver for solar thermal applications, 15:32290 (R;US)

CHEMICAL WARFARE AGENTS
Chemical and biological warfare: Defoliants and herbicides. January 1970-March 1990 (A Bibliography from the NTIS data base). Report for January 1970-March 1990, 15:33045 (R;US)

CHEMICAL WASTES
Assessing inhalation risks from the land treatment of petroleum refining wastes, 15:32151 (B;US)
Destruction of propellant components in supercritical water, 15:32806 (R;US)
Treatment and destruction of hazardous chemical wastes, 15:33106 (R;US)

CHI RESONANCES
See MESONS

CHI-2800 RESONANCES
See MESONS

CHI-3455 RESONANCES
See MESONS

CHILDREN
Unusual formaldehyde-induced hypersensitivity in two schoolgirls, 15:33257 (R;US)

CHINA
Anthropogenic sulfur dioxide emission in Far East Asia, 15:32098 (R;JP;In Japanese)
Energy in China, 15:32471 (R;FR;In French)

CHIRAL SYMMETRY
Chiral symmetry breaking in QED_3: bifurcation of the fermionic self-energy, 15:33503 (R;BR)

CHLOR-ALKALI INDUSTRY
See CHEMICAL INDUSTRY

CHLORINATED ALIPHATIC HYDROCARBONS
See also CHLOROFORM
PVC
VINYL CHLORIDE
Relationship between CO, POHC, and pic emissions from a simulated hazardous waste incinerator, 15:33086 (R;US)
Toxicological profile for chloroethane. Final report, 15:33243 (R;US)

CHLORINATED AROMATIC HYDROCARBONS
Ambient concentrations of PCDDs/PCDFs (polychlorinated dibenzodioxins/dibenzofurans) in the South Coast Air Basin. Final report, 1987-1990, 15:33068 (R;US)
Dechlorination of pentachlorophenol, 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid in anaerobic freshwater sediments, 15:33148 (R;US)
Multilaboratory validation study of PCBs in soils using Soxtec® extraction technique (Method 3541), 15:33119 (R;US)
Polychlorinated biphenyls: Occurrence in sediments and soils. January 1977-March 1990 (A Bibliography from the Selected Water Resources Abstracts data base). Report for January 1977-March 1990, 15:33187 (R;US)
Polychlorinated biphenyls: Progress and problems, 15:32807 (R;US)
Technology evaluation report: SITE program. CF Systems organics extraction system, New Bedford, Massachusetts. Volume 2. Final report, 15:33179 (R;US)
Technology evaluation report: SITE program. CF Systems organics extraction system, New Bedford, Massachusetts. Volume 1. Final report, 15:33178 (R;US)

CHLOROFORM
Health-hazard evaluation report HETA 87-075-1988, American Cyanamid, Wallingford, Connecticut, 15:33074 (R;US)

CHLOROPHYLL
Chlorophyll photochemistry in microheterogeneous media, 15:32279 (R;US)

CHLOROPLASTS
The manganese site of the photosynthetic water-splitting enzyme, 15:32285 (J;US)

CHONDRITES
Evolution of carbonaceous chondrite parent bodies: Insights into cometary nuclei, 15:33308 (RA;US)
Identification of solar nebula condensates in interplanetary dust particles and unequilibrated ordinary chondrites, 15:33306 (RA;US)

CHONDROSARCOMAS
See SARCOMAS

CHROMATOGRAPHIC COLUMNS
See EXTRACTION COLUMNS

CHROMIUM
Microstructural studies of IAD and PVD Cr coatings by cross section transmission electron microscopy, 15:32734 (BA;US)
Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the Salton Sea Area, California, 1986-87. Water-Resources investigation, 15:33164 (R;US)

CHROMIUM ALLOYS
See also ALLOY-NI49CR22FE18MO9
NICKEL-CHROMIUM STEELS
Melting of iron-aluminide alloys, 15:32044 (R;US)
Morphological and structural characterization of the spinodal decomposition of Fe-Cr alloys, 15:32536 (R;US)
[Neutron scattering studies of spatial correlations in Fe-V and Fe-Cr alloys]: Foreign trip report, September 30, 1989–April 23, 1990, 15:32554 (R;US)

CHROMIUM COMPOUNDS
High-temperature defect structure of Nb-doped $LaCrO_3$, 15:32669 (J;US)

CHROMIUM-MOLYBDENUM STEELS
Irradiation effects on impact behavior of 12Cr-1MoVW and 2 1/4Cr-1Mo steels, 15:32538 (R;US)
Thermal methods for healing defects in protective oxide films on alloys, 15:32543 (RA;US)

CHROMODYNAMICS
See QUANTUM CHROMODYNAMICS

CHRONIC EXPOSURE
Lawrence Livermore National Laboratory RCRA Part B health risk assessment: Phase 2, Hazardous waste management units: Appendices, 15:33230 (R;US)

CIRCUITS (ELECTRONIC)
See ELECTRONIC CIRCUITS

CITIES
See URBAN AREAS

CLASSICAL MECHANICS
Unexpected properties of the centrifugal force, 15:33694 (R;XA)

CLASSIFIED INFORMATION
Counterintelligence and operations security-support program for the Defense Nuclear Agency. Directive, 15:33020 (R;US)
Laser-guidance systems, security classification. Instruction, 15:33016 (R;US)
Security classification of information concerning high-energy lasers. Instruction, 15:33017 (R;US)

CLAYS
See also ILLITE
SMECTITE
Capillary suction-time tests on selected clays and shales. Master's thesis, 15:32128 (R;US)
Performance experience with radon mitigation systems, 15:32480 (R;US)

CLEAN AIR ACT
Air pollution: EPA's ambient air policy results in additional pollution, 15:33141 (R;US)

CLIMATES
A critical appraisal of model simulations, 15:33107 (R;US)
Atmospheric ozone 1985: Assessment of our understanding of the processes controlling its present distribution and change. Volume 3, 15:33078 (R;CH)
Climate Caucus report: Opportunities for bridging the gaps from effects to impacts, 15:33103 (R;US)
International decision making and global climate change: Lessons of prior resource management efforts for consensus building, 15:33053 (R;US)
Policy options for stabilizing global climate. Draft report to congress. Executive Summary. Draft report, 15:33079 (R;US)
Potential Effects of Global Climate Change on the United States. Appendix B. Sea-level rise. Report to the Congress, 15:33070 (R;US)
Potential Effects of Global Climate Change on the United States. Appendix G. Health. Report to the Congress, 15:33071 (R;US)
Potential Effects of Global Climate Change on the United States. Appendix H. Infrastructure. Report to the Congress, 15:33069 (R;US)
Potential Effects of Global Climate Change on the United States. Appendix L. Variability. Report to the Congress, 15:33072 (R;US)
Potential responses of landscape boundaries to global environmental change, 15:33051 (R;US)

CLOUDS
See also RADIOACTIVE CLOUDS
A parametric investigation of electrical effects on aerosol scavenging by droplets over large fires, 15:33108 (R;US)

CLUSTERS (FUEL ELEMENTS)
See FUEL ELEMENT CLUSTERS

CO-GENERATION
See COGENERATION

COAL
See also SUBBITUMINOUS COAL

Bioconversion
Reactors for scaling-up coal bioprocessing, 15:32067 (R;US)

Chemical Reactions
Inhibition of retrogressive reactions in coal/petroleum coprocessing: Quarterly technical progress report, December 1, 1989–February 28, 1990, 15:32053 (R;US)

Cleaning
Assessment of coal cleanability for various beneficiation processes by SEM-based automated image analysis, 15:32089 (J;NL)
The importance of clean coal technologies to reduce power plant emissions, 15:32312 (RA;US)

Combustion
Coal Combustion Science quarterly progress report, January–March 1990, 15:32118 (R;US)
Development of nondestructive evaluation methods and prediction of effects of flaws on the fracture behavior of structural ceramics, 15:32112 (R;US)
Heat engines program: Fiscal year 1990, Summary program plan, 15:32113 (R;US)
Results of emissions and ash testing in full-scale co-combustion tests of binder-enhanced dRDF pellets and high-sulfur coal, 15:32513 (R;US)

Combustion Kinetics
Reduction of ash sticking in direct coal-fired gas turbine engines, 15:32120 (BA;US)

Combustion Products
History and some potentials of oil shale cement, 15:32190 (R;US)

Comminution
Comminution employing liquid nitrogen pretreatments, 15:32040 (RA;US)

Compiled Data
Quarterly coal report, October–December 1989, 15:32121 (R;US)

Coprocessing
A techno-economic evaluation of copressing technologies, 15:32079 (BA;US)
Co-processing and tar-sands resid: A new approach to alternative transportation fuels, 15:32078 (BA;US)
Inhibition of retrogressive reactions in coal/petroleum coprocessing: Quarterly technical progress report, December 1, 1989–February 28, 1990, 15:32053 (R;US)

Deashing
Coal flotation and flocculation in the presence of humic acids, 15:32037 (RA;US)

Dechlorination
Mechanistic study of chlorine removal from coal by high-temperature leaching, 15:32054 (RA;US)

Desulfurization
Fossil fuels: Status of DOE-funded clean coal technology projects as of March 19, 1989, 15:32043 (R;US)
Genetic approach to microbial coal desulfurization, 15:32056 (RA;US)
Genetic manipolation of acidophilic bacteria, 15:32077 (BA;US)
Microbial removal of organic sulfur from coal (bacterial degradation of sulfur containing heterocyclic compounds), 15:32055 (RA;US)
Studies of the energetics of C-S bond-breaking reactions in radical ions derived from coal model compounds, 15:32084 (RA;US)

Flash Hydropyrolysis Process
Contribution to the study of complex physical phenomena in gas-solid reactors for coal hydro-pyrolysis, 15:32069 (R;FR;In French)

Flocculation
A new approach in ultrapurification of coal by selective flocculation: Quarterly report, 15:32052 (R;US)

Fuel Slurries
Industrial burners for combustion of high concentration water-coal slurries and respective combustion, 15:32116 (R;XE)

Hydrogenation
Coal liquefaction and hydrogenation: Processes and equipment. September 1971-November 1989 (A Bibliography from the US Patent data base). Report for September 1971-November 1989, 15:32074 (R;US)

Injection
Effect of blast furnace coal injection upon bosh coke properties, coke combustion and furnace permeability, 15:32117 (R;XE)

Market
Introduction to the Argonne Utility Simulation (ARGUS) model, 15:32470 (R;US)

Nuclear Magnetic Resonance
Local structure evaluation in solid amorphous mixtures by double cross polarization C13 nuclear magnetic resonance spectrometry, 15:32086 (BA;US)
Variable temperature high speed spinning CP/MAS NMR studies of coals, 15:32087 (BA;US)

Organic Sulfur Compounds
New analytical methods for organic sulfur in coal, 15:32085 (BA;US)

Pollution Control
The removal and control of trace elements in coal and coal wastes, 15:32093 (RA;US)

Pulse Combustion
Beneficiated fine-particle coal as a source of energy in small-scale applications, 15:32115 (RA;US)

Pyrolysis
Pyrolytic behavior of a coal particle: Effect of unsteady state heating and temperation gradients, 15:32076 (BA;US)

Quantitative Chemical Analysis
New analytical methods for organic sulfur in coal, 15:32085 (BA;US)
Supercritical extraction-time-of-flight mass spectrometry with electron impact ionization of coal and coal model compounds, 15:32088 (BA;US)

Research Programs
High-sulfur coal research at the SIUC Coal Technology Laboratory: Quarterly progress report, January 1–March 31, 1990, 15:32042 (R;US)
High-sulfur coal research at the SIUC [Southern Illinois University at Carbondale] Coal Technology Laboratory: Quarterly progress report, January 1–March 31, 1990, 15:32041 (R;US)
The cooperative research and development endeavor, 15:32036 (R;US)

Solvent Extraction
Sulfur species in perchloroethylene and other coal extracts, 15:32780 (R;US)

Spectroscopy
Variable temperature high speed spinning CP/MAS NMR studies of coals, 15:32087 (BA;US)

Sulfur Compounds
Sulfur compounds in coals containing multiple heteroatoms, 15:32108 (BA;US)

Surface Properties
Enhancement of surface properties for coal beneficiation: Technical progress report, January 1, 1990–March 31, 1990, 15:32083 (R;US)

COAL DEPOSITS
See also COAL SEAMS
Geologic evaluation of critical production parameters for coalbed methane resources. Part 1. San Juan Basin. Annual report, August 1988-July 1989, 15:32106 (R;US)

COAL FINES
Transient group combustion: Steady state simulation and transient results, 15:32119 (BA;US)

COAL GASIFICATION
See also DOW GASIFICATION PROCESS
Coal gasification. March 1972-January 1990 (A Bibliography from the US Patent data base). Report for March 1972-January 1990, 15:32075 (R;US)
Contribution to the study of a steam arc plasma. Application to pulverized coal gasification, 15:32070 (R;FR;In French)
Development of an advanced, continuous mild gasification process for the production of co-products: Quarterly technical progress report, October–December 1989, 15:32051 (R;US)
Production of jet fuels from coal derived liquids: Volume 9, Results of bench-scale testing and pilot plant testing: Interim report, February 1988–March 1989, 15:32059 (R;US)

COAL GASIFICATION PLANTS
Dow Syngas Project Monitoring Review Committee Meeting Report. Held in Plaquemine, Louisiana on September 14, 1989, 15:32073 (R;US)
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 29, January 1–March 31, 1989, 15:32065 (R;US)
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 23, July 1–September 30, 1988, 15:32063 (R;US)
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 25, October 1–December 31, 1988, 15:32064 (R;US)
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 17, April 1–June 30, 1988, 15:32062 (R;US)
Production of jet fuel from coal-derived liquids: Report No. 16: Quarterly technical progress report, second quarter FY 1988, January 1, 1988–March 31, 1988, 15:32061 (R;US)
Production of jet fuels from coal derived liquids: Volume 6, Preliminary analysis of upgrading alternatives for the Great Plains liquid by-product streams: Interim report, March 1987–February 1988, 15:32058 (R;US)
Production of jet fuels from coal-derived liquids: Volume 12, Preliminary process design and cost estimate and production run recommendation: Final report, March 1989–December 1989, 15:32060 (R;US)
Waste Management: Final technical report, April 1, 1987–March 31, 1988 including Quarterly technical progress report, January–March 1988, 15:32090 (R;US)

COAL LIQUEFACTION
Coal Liquefaction Program: Fiscal year 1990, Summary program plan, 15:32046 (R;US)
Coal liquefaction and hydrogenation: Processes and equipment. September 1971-November 1989 (A Bibliography from the US Patent data base). Report for September 1971-November 1989, 15:32074 (R;US)
Modification of coal surfaces with methyl radicals, 15:32057 (RA;US)

COAL LIQUIDS
Mild gasification liquid characterization data for sytems modeling and assesment, 15:32080 (BA;US)

COAL MINES
Improved emission factors for fugitive dust from Western surface coal mining sources. Volume 2. Emission factors, 15:32111 (R;US)
Improved emission factors for fugitive dust from Western surface-coal-mining sources. Volume 1. Sampling methodology and test results, 15:32110 (R;US)

COAL MINING
Comparison of hydrologic data from mined and unmined areas in the carbondale Group of Daviess, Pike, and Gibson Counties, Indana. Final report, 15:32100 (R;US)
Determination of drainage density for surface-mine reclamation in the western US. Final report, 15:32099 (R;US)
Identification of hydro data sources for use in mine plan review assessment of cumulative hydrologic impacts of surface mines Final report, 15:32104 (R;US)
Soil survey versus crop production as a measure of soil productivity: Soil characteristics as predictors of corn and soybean yields, NCSS (National Cooperative Soil Survey) data base. Final report, 15:32102 (R;US)
Soil survey versus crop production as a measure of soil productivity: Soil-strength effects on row-crop yields. Final report, 15:32103 (R;US)
Surface mining: Information of legal fees under the surface mining act, 15:32109 (R;US)
Surface-water hydrology and sedimentology manual. Final report, 15:32101 (R;US)

COAL PREPARATION
Estimated reductions in SO_2 emissions from the 100 largest electric utility power plant emitters through coal cleaning, 15:32313 (RA;US)
Fossil fuels: Status of DOE-funded clean coal technology projects as of March 19, 1989, 15:32043 (R;US)
High-sulfur coal research at the SIUC [Southern Illinois University at Carbondale] Coal Technology Laboratory: Quarterly progress report, January 1–March 31, 1990, 15:32041 (R;US)
Waste Management: Final technical report, April 1, 1987–March 31, 1988 including Quarterly technical progress report, January–March 1988, 15:32090 (R;US)

COAL SEAMS
Geologic evaluation of critical production parameters for coalbed methane resources. Part 1. San Juan Basin. Annual report, August 1988-July 1989, 15:32106 (R;US)

COAL TAR OILS
See also NAPHTHA
Jet fuels potential of liquid by-products from the Great Plains Gasification Project, 15:32048 (R;US)
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 17, April 1–June 30, 1988, 15:32062 (R;US)
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 23, July 1–September 30, 1988, 15:32063 (R;US)

Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 25, October 1–December 31, 1988, 15:32064 (R;US)
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 29, January 1–March 31, 1989, 15:32065 (R;US)
Production of jet fuel from coal-derived liquids: Report No. 16: Quarterly technical progress report, second quarter FY 1988, January 1, 1988–March 31, 1988, 15:32061 (R;US)
Production of jet fuels from coal derived liquids: Volume 6, Preliminary analysis of upgrading alternatives for the Great Plains liquid by-product streams: Interim report, March 1987–February 1988, 15:32058 (R;US)
Production of jet fuels from coal derived liquids: Volume 9, Results of bench-scale testing and pilot plant testing: Interim report, February 1988–March 1989, 15:32059 (R;US)

COAL-DERIVED LIQUIDS
See COAL LIQUIDS

COAL-FIRED GAS TURBINES
Reduction of ash sticking in direct coal-fired gas turbine engines, 15:32120 (BA;US)

COAL-OIL MIXTURES
See COAL
FUEL SLURRIES

COAST
See SHORES

COASTAL WATERS
The coast guard's cleanup of hazardous waste sites, 15:33126 (R;US)

COATING (SURFACE)
See SURFACE COATING

COATING PROCESSES
See SURFACE COATING

COBALT
Abrupt interfaces with novel structural and electronic properties: Metal-cluster deposition and metal-semiconductor junctions, 15:32600 (J;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 7. Primary beryllium, primary nickel and cobalt, secondary nickel, secondary tin. Final report, 15:33160 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 6. Primary tungsten, secondary tungsten and cobalt, primary molybdenum and rhenium, secondary molybdenum and vanadium. Final report, 15:33159 (R;US)

COBALT 58
Examination of the impact of radioactive liquid effluent releases from the Rancho Seco Nuclear Power Plant, 15:33190 (J;US)

COBALT 60
Examination of the impact of radioactive liquid effluent releases from the Rancho Seco Nuclear Power Plant, 15:33190 (J;US)
Long-term stability of solid standards for radiochemical analysis, 15:32785 (R;US)
Mechanisms of ^{60}Co uptake and loss by Scenedesmus obliquus and transfer to two benthic organisms, 15:33138 (R;FR;In French)
Radionuclide uptake by pinetrees growing on lysimeters, 15:33123 (R;US)

COBALT OXIDES
Orbital polarization and the insulating gap in the transition-metal oxides, 15:32673 (J;US)

COCAINE
The study of drugs of abuse with an ion trap mass spectrometer, 15:33216 (BA;US)

COGENERATION
Diagnostic tools for reciprocating engine cogeneration systems. Phase 1, final report, June 1989-December 1989, 15:32508 (R;US)
Technical and economic evaluation of diesel engine with oxygen enrichment and water injection, 15:32502 (R;US)

COGENERATION PLANTS
See DUAL-PURPOSE POWER PLANTS

COHERENT ANTI-STOKES RAMAN SPECTROSCOPY
See RAMAN SPECTROSCOPY

COILS (ELECTRIC)
See ELECTRIC COILS

COKE
Effect of blast furnace coal injection upon bosh coke properties, coke combustion and furnace permeability, 15:32117 (R;XE)
Oil shale quarterly report, April–December 1989, 15:32186 (R;US)
Reducing sulphur in coke, 15:32068 (R;XE)

COLD PLASMA
Mode conversion between Alfven wave eigenmodes in axially inhomogeneous two-ion-species plasmas, 15:33796 (J;US)
Non-stationary computer model of the asymptotic region of an electric arc gas heater, 15:33742 (RA;CS)

COLLECTIVE MODEL
Generalized valley approximation applied to a schematic model of the monopole excitation, 15:33585 (J;US)

COLLECTOR PROPERTIES
See PERMEABILITY

COLLECTOR PROPERTIES (ROCKS)
See PERMEABILITY

COLLIERIES
See COAL MINES

COLLISIONAL PLASMA
Smooth plasma-sheath transition in a hydrodynamic model–, 15:33830 (J;US)

COLLISIONLESS PLASMA
Nonlinear effects in a plasma with structured magnetic fields, 15:33758 (RA;CS)
Smooth plasma-sheath transition in a hydrodynamic model–, 15:33830 (J;US)

COLORADO
Geologic evaluation of critical production parameters for coalbed methane resources. Part 1. San Juan Basin. Annual report, August 1988-July 1989, 15:32106 (R;US)

COLUMBIUM
See NIOBIUM

COLUMNS (EXTRACTION)
See EXTRACTION COLUMNS

COMANCHE PEAK-1 REACTOR
Technical Specifications, Comanche Peak Steam Electric Station, Unit 1 (Docket No. 50-445): Appendix "A" to License No. NPF-87, 15:32322 (R;US)

COMBINED GAS AND STEAM CYCLE POWER PLANTS
See COMBINED-CYCLE POWER PLANTS

COMBINED STEAM-POWER GENERATION
See COGENERATION

COMBINED-CYCLE POWER PLANTS
Development of fixed-bed-type hot-gas-cleanup technology for coal-derived gas, 15:32072 (R;JP)

COMBUSTION CHAMBERS
Auto-ignition temperatures of binary mixtures of alkanes in a closed vessel: Comparisons between experimental measurements and numerical predictions, 15:32837 (R;US)

COMBUSTION KINETICS
Modelling of flamelet surface-to-volume ratio in turbulent premixed combustion, 15:32861 (R;US)

COMBUSTORS
See also FLUIDIZED-BED COMBUSTORS
Market review of demand for industrial waste combustors for on-site use, 15:32269 (R;GB)
Utility retrofit demonstration using TRW slagging combustor technology: Environmental Assessment, 15:32309 (R;US)

COMETS
Evolution of carbonaceous chondrite parent bodies: Insights into cometary nuclei, 15:33308 (RA;US)
Role of dust to gas production rate ratio in cometary physics, 15:33305 (RA;US)
The volatile composition of comets, 15:33301 (R;US)
Trace element abundance determinations by Synchrotron X Ray Fluorescence (SXRF) on returned comet nucleus mineral grains, 15:33304 (RA;US)

Workshop on Analysis of Returned Comet Nucleus Samples, 15:33303 (R;US)

COMMERCIAL BUILDINGS
See also RESTAURANTS
Energy conservation program evaluation: Practical methods, useful results: Proceedings: Volume 2, August 20 and 21 sessions, 15:32479 (R;US)
Lumen Day: A new concept for daylighting design in commercial buildings. Final report on Phase 1, 15:32486 (R;US)
NIOSH (National Institute for Occupational Safety and Health) testimony on indoor air quality by J. Melius on August 3, 1983, 15:33077 (R;US)
NIOSH (National Institute for Occupational Safety and Health) testimony on indoor air quality by J. D. Millar on May 26, 1989, 15:33076 (R;US)

COMPACT IGNITION TOKAMAK
Microwave generation for magnetic fusion energy applications, Task A: Progress report, September 15, 1989–September 14, 1990, 15:33732 (R;US)

COMPACT TORUS
US-Japan workshop on field-reversed configurations with steady-state high-temperature fusion plasmas and the 11th US-Japan workshop on compact toroids, 15:33820 (R;US)

COMPACTIFICATION
Zero modes in vortex-fermion system with compact extra space, 15:33477 (R;JP)

COMPILED DATA
North Slope investigation report, 15:33135 (R;US)

COMPLEX MANIFOLDS
A corollary to Kodaira-Spencer's theorem on continuity of eigenvalues, 15:33692 (R;XA)

COMPONENT COOLING SYSTEMS
See AUXILIARY WATER SYSTEMS

COMPOSITE MATERIALS
See also SUPERCONDUCTING COMPOSITES
A new technique for simulating composite material. Task 2: Analytical solutions with generalized impedance boundary conditions (GIBCs). Report, September 1989-February 1990, 15:32705 (R;US)
A particle-level numerical simulation of the dynamic consolidation of a metal matrix composite material, 15:32612 (R;US)
Friction and wear of whisker-reinforced ceramic composite bodies, 15:32609 (R;US)
Metal matrix composites. July 1971-February 1990 (A Bibliography from the US Patent data base). Report for July 1971-February 1990, 15:32707 (R;US)
Novel method for constructing tetrahedral frames, 15:32731 (BA;US)

COMPOST
Investigation on the utilization of coal fly ash as amendment to compost for vegetation in acid soil: Progress report, March 16, 1989–April 15, 1990, 15:32092 (R;US)

COMPOUNDS (ORGANIC)
See ORGANIC COMPOUNDS

COMPRESSIBLE FLOW
COYOTE: A computer program for 2-D reactive flow simulations, 15:33387 (R;US)

COMPRESSION
A particle-level numerical simulation of the dynamic consolidation of a metal matrix composite material, 15:32612 (R;US)

COMPTON SPECTROMETERS
Flash x-ray measurements with a time projection Compton spectrometer, 15:33009 (R;US)

COMPUTER CODES
See also A CODES
C CODES
F CODES
G CODES
P CODES
Q CODES
S CODES
TRANSLATORS
Application of Fabry-Perot velocimeter to high-speed experiments, 15:32981 (BA;US)
Application of near real time accountancy to nuclear material balance data, 15:32257 (R;DE)
LLUVIA: A program for one-dimensional, steady-state flow through partially saturated porous media, 15:32235 (R;US)

COMPUTER NETWORKS
Graph Structure Model, 15:33849 (R;US)
Using the multistage cube network topology in parallel supercomputers, 15:33856 (J;US)

COMPUTER PROGRAMMING
See PROGRAMMING

COMPUTER PROGRAMS
See COMPUTER CODES

COMPUTER-AIDED DESIGN
Computer-aided engineering annual report for calendar year 1989, 15:33845 (R;US)

COMPUTER-AIDED MANUFACTURING
IPPEX [Inspection Process Planning EXpert]: An automated planning system for dimensional inspection, 15:33848 (R;US)
Archimedes: An experiment in automating mechanical assembly, 15:32856 (R;US)

COMPUTERIZED CONTROL SYSTEMS
A hierarchical approach to large space structure control, 15:32497 (R;US)
DOE requirements for the next generation controller, 15:33038 (R;US)

COMPUTERS
See also HYPERCUBE COMPUTERS
MICROPROCESSORS
NIST (National Institute of Standards and Technology) research reports, January 1990. Special pub, 15:33631 (R;US)
Technical publication transfer test with Boeing Computer Services: MIL-M-28001 (SGML) and MIL-D-28000 Class I (IGES): Quick short test report, 15:33855 (R;US)

CONDENSERS (ELECTRIC)
See CAPACITORS

CONDUCTIVITY (ELECTRIC)
See ELECTRIC CONDUCTIVITY

CONDUCTIVITY (THERMAL)
See THERMAL CONDUCTIVITY

CONSERVATION (ENERGY)
See ENERGY CONSERVATION

CONSERVATION (RESOURCE)
See RESOURCE CONSERVATION

CONSTRUCTION
A hierarchical approach to large space structure control, 15:32497 (R;US)

CONTACT RADIOTHERAPY
See RADIOTHERAPY

CONTACTS (ELECTRIC)
See ELECTRIC CONTACTS

CONTAINERS
See also CASKS
PRESSURE VESSELS
REACTOR VESSELS
Experiments on container materials for Swiss high-level waste disposal projects. Part IV, 15:32550 (R;CH)

CONTAINMENT BUILDINGS
3-D FEM analysis of 1:6 scale reinforced concrete containment under static overpressurization and local analysis of liner plant tearing, 15:32401 (RA;US)
Analysis predictions vs. test results of the 1:6-scale reinforced concrete containment tested at Sandia National Laboratories, 15:32398 (RA;US)
Analytical correlation and post-test analysis of the Sandia 1:6 scale reinforced concrete containment test, 15:32399 (RA;US)
Comparison between theoretical and experimental results of the 1/6 scale concrete model under internal pressure, 15:32397 (RA;US)
NFAP calculation of pressure response of 1/6th scale model containment structure, 15:32394 (RA;US)
Post-test analysis of a piping penetration in a 1:6-scale model of a reinforced concrete containment building, 15:32400 (RA;US)
Progress in post-test analyses of a 1:6 scale lined and reinforced concrete containment model, 15:32393 (RA;US)

Proposals for a one tenth scale model test of the Sizewell B containment, 15:32391 (RA;US)
Some post-test analyses of the 1/6th Sandia containment, 15:32396 (RA;US)
Synopsis of the results of a test of a reinforced concrete containment, 15:32395 (RA;US)

CONTAINMENT SHELLS
A magnetographic technique for inspection of containment welds through coatings: Final report, 15:32337 (R;US)
Comparison between calculated and measured eigenfrequencies for spherical steel containment shells, 15:32389 (RA;US)

CONTAINMENT SYSTEMS
Containment integrity beyond the design basis: A UK regulatory view, 15:32378 (RA;US)
Containment loading by deliberate ignition of flammable gas mixtures, 15:32381 (RA;US)
Containment long-term operational integrity–a 1988 status report, 15:32377 (RA;US)
Design considerations for severe accident containment performance, 15:32379 (RA;US)
Development of a hydrogen mitigation strategy for degraded core accidents in a BWR/6 - Mark III power plant, 15:32385 (RA;US)
Experimental study for structural behavior of reinforced concrete containment vessel beyond design pressure, 15:32390 (RA;US)
Ice melting progress in a nonuniformly loaded ice condenser facility, 15:32383 (RA;US)
Maintaining leak tightness capability of Caorso BWR containment, 15:32384 (RA;US)
Parametric CONTAIN calculations of the containment response of the Grand Gulf plant due to reactor pressure vessel failure at high pressure, 15:32382 (RA;US)
Proposed acceptance criteria for severe accident evaluations of steel containment vessels, 15:32380 (RA;US)
Proving Test on the Reliability for Reactor Containment Vessel, 15:32388 (RA;US)
Seismic uplift of nuclear containments, 15:32386 (RA;US)
The design of a 1/10th scale model of the Sizewell B Primary Containment, 15:32392 (RA;US)
The influence of data collection rate, containment size and data smoothing on containment Integrated Leak Rate Tests, 15:32387 (RA;US)

CONTAMINATION
Multimedia assessment of health risks for the Weldon Spring site remedial action project, 15:32202 (R;US)
Remedial Action Assessment System (RAAS): Evaluation of selected feasibility studies of CERCLA [Comprehensive Environmental Response, Compensation, and Liability Act] hazardous waste sites, 15:32229 (R;US)

CONTENT ANALYSIS
See CHEMICAL ANALYSIS

CONTROL ROOMS
Human factors survey of advanced instrumentation and controls, 15:32409 (RA;US)
The effects of local control station design variation on plant risk, 15:32410 (RA;US)

CONTROL SYSTEMS
See also COMPUTERIZED CONTROL SYSTEMS
REACTOR CONTROL SYSTEMS
Accelerator diagnosis and control by Neural Nets, 15:32949 (BA;US)
Control loop and unit operational realtime modeling on a Distributed Control System, 15:32242 (R;US)
Performance experience with radon mitigation systems, 15:32480 (R;US)
The Colliding Beams Sequencer, 15:32950 (BA;US)

COOLANT CLEANUP SYSTEMS
Preliminary observations of upcoming Phase II gate valve flow interruption tests, 15:32408 (RA;US)

COOLERS
See HEAT EXCHANGERS

COOLING SYSTEM (REACTOR)
See REACTOR COOLING SYSTEMS

COPOLYMERS
Photoinduced charge separation by polymer-bound chromophores: Progress report, September 1986–December 1989, 15:32825 (R;US)

COPPER
Anomalous copper diffusion through samarium, 15:32751 (J;US)
Cascade collapse in copper and nickel, 15:32540 (R;US)
Concentrations of metals in Norton Sound seawater samples and human hair samples, 1989, 15:33188 (R;US)
Determination of the bulk band structure of Ag in Ag/Cu(111) quantum-well systems, 15:32599 (J;US)
Deuterium interactions with ion-implanted oxygen in Cu and Au, 15:33344 (BA;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 3. Primary copper smelting, primary electrolytic copper refining, secondary copper, metallurgical acid plants. Final report, 15:33156 (R;US)
Effect of Cu^{2+} magnetic moments on the superconductivity of $YBa_2Cu_3O_7$: The origin of the "linear term" in the specific heat; The volume fraction of superconductivity, 15:32613 (R;US)
Encoding of the Burgess metal electrical resistivity model into SESAME format and its adaptation to the metal nickel, 15:32548 (R;US)
Health assessment for Beachwood Borough and Berkeley Township National Priorities List (NPL) Site, Ocean County, New Jersey, Region 2. CERCLIS No. NJD980654123. Final report, 15:33142 (R;US)
Mechanistic aspects of reductions by hot electrons in p-InP/acetonitrile photoelectrochemical cells, 15:32824 (J;US)
Multiple sulfur sites in the Cu(100)$p(2\times2)$-S surface structure, 15:32601 (J;US)
National Performance Audit Program: Acid rain audits, 1988, 15:33082 (R;US)
A dependence of highly inelastic *p*-nucleus collisions, 15:33418 (J;US)
A dependence of J/ψ production in π^--nucleus collisions at 530 GeV/*c*, 15:33411 (J;US)

COPPER 63 TARGET
Three paths for intermediate-mass fragment formation at a near-onset excitation energy of 1.3 MeV/nucleon, 15:33538 (J;US)

COPPER ALLOYS
Amorphous and metastable phase formation in systems with positive heats of mixing using high-rate sputter deposition, 15:32569 (BA;US)
Neutron scattering experiments on $YbXCu_4$ and $ErXCu_4$ (*X*=Au, Pd, and Ag), 15:32591 (J;US)
Role of melting temperature on the properties of displacement cascades, 15:32541 (R;US)
The effect of simultaneous electron and Kr^+ irradiation on amorphization of CuTi, 15:32575 (BA;US)

COPPER CHLORIDES
Antiferromagnetism in $Sr_2CuO_2Cl_2$, 15:32676 (J;US)
Synthesis, structure, and properties of $Sr_2CuO_2Cl_2$, 15:32675 (J;US)

COPPER OXIDES
Antiferromagnetism
Magnetic order of the Cu planes and chains in $RBa_2Cu_3O_{6+x}$, 15:32685 (J;US)
Magnetic ordering in $(Y_{1-x}Pr_x)Ba_2Cu_3O_7$ as observed by muon-spin relaxation, 15:32693 (J;US)

Chemical Reactions
High T_c oxide solid state reaction kinetics via complex impedance spectroscopy, 15:32802 (R;US)

Critical Field
Upper critical field of a $Sm_{1.85}Ce_{0.15}CuO_{4-y}$ single crystal: Interaction between superconductivity and antiferromagnetic order in copper oxides, 15:32670 (J;US)

Crystal-Phase Transformations
Structural and superconducting properties of oxygen-deficient $NdBa_2Cu_3O_{7-\delta}$, 15:32688 (J;US)

Doped Materials
Dynamical information for Fe doped $YBa_2Cu_3O_7$ superconducting oxides obtained from high temperature Moessbauer studies, 15:32602 (R;BR)
Electronic Structure
Orbital polarization and the insulating gap in the transition-metal oxides, 15:32673 (J;US)
Energy Beam Deposition
YBCO films on YSZ and Al_2O_3 by pulsed laser deposition, 15:32631 (BA;US)
Holes
O 2*p* holes: Temperature effects and surface characteristics of cuprate superconductors, 15:32689 (J;US)
Josephson Effect
Interlayer coupling in high temperature superconductors, 15:32647 (BA;US)
Light Transmission
Infrared synchrotron-radiation transmission measurements on $YBa_2Cu_3O_{7-\delta}$ in the gap and supercurrent regions, 15:32691 (J;US)
Magnetic Properties
Complex magnetic properties of the rare-earth copper oxides, R_2CuO_4, observed via measurements of the dc and ac magnetization, EPR, microwave magnetoabsorption, and specific heat, 15:32677 (J;US)
Magnetic ordering of Nd in $(Nd,Ce)_2CuO_4$, 15:32680 (J;US)
Nuclear Quadrupole Resonance
Calculation of the nuclear quadrupole resonance spectra of $YBa_2Cu_3O_{7-x}$, 15:32640 (BA;US)
Order Parameters
Magnetism, specific heat, and pressure-dependent reistivity of the electron-doped compounds LnMCuO(Ln = Pr,Nd,Sm,Eu,Gd:M = Ce,Th), 15:32641 (BA;US)
Superconductivity and magnetism in $La_2CuO_{4+\delta}$ by μSR, 15:32633 (BA;US)
Parametric Analysis
Major normal and superconducting parameters of high-T_c oxides, 15:32690 (J;US)
Phase Diagrams
Structural phase diagram of the $Ba_{1-x}K_xBiO_3$ system, 15:32687 (J;US)
Phase Studies
$La_2CuO_{4+gd}$and La_2NiO_{4+gd}: Phase separation resulting from excess oxygen defects, 15:32619 (BA;US)
Photoemission
Polarized resonance photoemission for Nd_2CuO_4, 15:32694 (J;US)
Physical Properties
Antiferromagnetism in $Sr_2CuO_2Cl_2$, 15:32676 (J;US)
Calcium-substituted Y-Ba-Cu-O superconductors with enhanced T_c synthesized at elevated oxygen pressures, 15:32686 (J;US)
Phase separation in a high-pressure-oxygenated $La_2CuO_{4+\delta}$ crystal: Evidence from anisotropic electronic transport and magnetic susceptibility, 15:32683 (J;US)
Superconducting thin films of YBaCu oxides prepared by MOCVD, 15:32607 (R;US)
Synthesis, structure, and properties of $Sr_2CuO_2Cl_2$, 15:32675 (J;US)
Sintering
Rapid thermal processing of high temperature superconducting fiber, 15:32616 (R;US)
Specific Heat
Effect of Cu^{2+} magnetic moments on the superconductivity of $YBa_2Cu_3O_7$: The origin of the "linear term" in the specific heat; The volume fraction of superconductivity, 15:32613 (R;US)
Sputtering
In-situ growth of superconducting films of Bi-Sr-Ca-Cu-O using magnetron sputtering, 15:32604 (R;US)
Superconducting Films
Hall effect mesurements in thin films of $Tl_2Ba_2CaCu_2O_x$, 15:32661 (BA;US)
Surface resistance of $YBa_2Cu_3O_7$ films deposited on $LaGaO_3$ substrates, 15:32900 (BA;US)
Superconductivity
Chemistry and superconducting behavior of Sb-substituted Bi/Pb-based oxides, 15:32626 (BA;US)
Effects of zinc substitution on the electron superconductor $Nd_{1.85}Ce_{0.15}CuO_{4-\delta}$, 15:32692 (J;US)
Evidence for a charge-density wave or spin-density wave in the Cu-O chains in $YBa_2Cu_3O_{7-x}$, 15:32678 (J;US)
Magnetic order of the Cu planes and chains in $RBa_2Cu_3O_{6+x}$, 15:32685 (J;US)
Microwave surface impedance of granular superconductors, 15:32664 (BA;US)
Phenomenological theory of magnetic structure in the high-temperature superconductors, 15:32662 (BA;US)
Processing chemically prepared $YBa_2Cu_3O_7$ precursor powders, 15:32898 (BA;US)
S-N-S behavior of grain boundaries in polycrystalline $La_{1.85}Sr_{0.15}CuO_{4-y}$, 15:32901 (BA;US)
Structural and superconducting properties of oxygen-deficient $NdBa_2Cu_3O_{7-\delta}$, 15:32688 (J;US)
Superconducting properties of grain boundaries in dense, fine grained $YBa_2Cu_3O_x$, 15:32660 (BA;US)
Superconductivity and magnetic scattering in the $Nd_{2-x}Ce_xCuO_{4-gd}$, 15:32618 (BA;US)
Superconductors
Dynamical information for Fe doped $YBa_2Cu_3O_7$ superconducting oxides obtained from high temperature Moessbauer studies, 15:32602 (R;BR)
The production of high performance $YBa_2Cu_3O_7$ using nitrogen dioxide, 15:32666 (J;US)
Transition Temperature
Magnetic and pairing correlations in a three band Hubbard model, 15:32646 (BA;US)

COPPER VAPOR LASERS
See GAS LASERS

CORES (REACTOR)
See REACTOR CORES

CORIUM
Thermal behavior of cohesive debris beds in a degraded nuclear reactor, 15:32319 (R;US)

CORN (MAIZE)
See MAIZE

CORN STOVER
See MAIZE

CORNELL ELECTRON-POSITRON STORAGE RING
See CESR STORAGE RING

CORONA DISCHARGES
Corona enhanced absorption of SO_2/NO_x, 15:32091 (RA;US)

COSMIC DUST
Computer simulation of dust grain evolution, 15:33307 (RA;US)
Identification of solar nebula condensates in interplanetary dust particles and unequilibrated ordinary chondrites, 15:33306 (RA;US)
Trace element abundance determinations by Synchrotron X Ray Fluorescence (SXRF) on returned comet nucleus mineral grains, 15:33304 (RA;US)

COSMIC GAMMA RAYS
See COSMIC PHOTONS

COSMIC GASES
Shapes of star-gas waves in spiral galaxies, 15:33297 (R;US)

COSMIC PARTICLES
See COSMIC RADIATION

COSMIC PHOTONS
Cosmology with 100-TeV γ-ray telescopes, 15:33317 (J;US)

COSMIC PROTONS
Ultrahigh-energy particle flux from cosmic strings, 15:33290 (R;US)

COSMIC RADIATION
See also COSMIC PHOTONS
COSMIC PROTONS
Aspects of the Zel'dovich-Sunyaev mechanism, 15:33318 (J;US)
Solar-Geophysical Data Number 544, December 1989. Part 1 (prompt reports). Data for November, October 1989, and late data, 15:33312 (R;US)

Stochastic simulation of charged particle transport on the massively parallel processor, 15:33302 (RA;US)

COSMIC X RAYS
See COSMIC PHOTONS

COSMIC X-RAY SOURCES
X-ray spectral signatures of photoionized plasmas, 15:33325 (J;US)

COSMOGONY
See COSMOLOGY

COSMOLOGICAL CONSTANT
Non-linear σ-models and string theories, 15:33511 (BA;US)

COSMOLOGICAL MODELS
See also INFLATIONARY UNIVERSE
Gravitational effects of global textures, 15:33289 (R;US)
Millisecond-pulsar constraint on cosmic strings, 15:33324 (J;US)
Viscous causal cosmologies, 15:33284 (R;BR)

COSMOLOGY
Electroweak BAU generation on the lattice: Real time vs. Euclidean approach, 15:33507 (R;DK)
False vacuum decay in Jordan-Brans-Dicke cosmologies, 15:33285 (R;US)
Non-linear σ-models and string theories, 15:33511 (BA;US)

COSMOS
See UNIVERSE

COULOMB ATTRACTION
See COULOMB FIELD

COULOMB BARRIER
See COULOMB FIELD

COULOMB FIELD
Relativistic calculation, in quantum electrodynamic, of the Compton diffusion on a bound electron, 15:33510 (R;FR;In French)

COULOMB POTENTIAL
See COULOMB FIELD

COULOMB REPULSION
See COULOMB FIELD

COUNTERS (RADIATION)
See RADIATION DETECTORS

COUPLINGS (MACHINE PARTS)
See MACHINE PARTS

CP INVARIANCE
A flaw in the universal mirror, 15:33480 (J;US)
Searching for *CP* violation in "charge-blind" jets, 15:33483 (J;US)

CRACKS
A magnetographic technique for inspection of containment welds through coatings: Final report, 15:32337 (R;US)

CRESOLS
Production of jet fuel from coal-derived liquids: Report No. 16: Quarterly technical progress report, second quarter FY 1988, January 1, 1988–March 31, 1988, 15:32061 (R;US)
Production of jet fuels from coal derived liquids: Volume 6, Preliminary analysis of upgrading alternatives for the Great Plains liquid by-product streams: Interim report, March 1987–February 1988, 15:32058 (R;US)

CRESYLIC ACID
See CRESOLS

CRITICAL FLOW
Assessment of TRAC-PF1/MOD1 version 14.3 using separate effects critical flow and blowdown experiments: Volume 1, Test and tables, 15:32423 (R;US)

CRITICALITY
Criticality experiments with neutron flux traps containing voids, 15:32198 (R;US)
Development of the criticality accident analysis code, AGNES, 15:32849 (RA;JP;In Japanese)
Executive summary: Reactor critical benchmark calculations for burnup credit applications, 15:32333 (R;US)
Spatial dependence of the spectral-ratio in Mihalczo method, 15:32850 (RA;JP;In Japanese)

CRITICALITY ACCIDENTS
See CRITICALITY
RADIATION ACCIDENTS

CROPS
Soil survey versus crop production as a measure of soil productivity: Soil characteristics as predictors of corn and soybean yields, NCSS (National Cooperative Soil Survey) data base. Final report, 15:32102 (R;US)
Soil survey versus crop production as a measure of soil productivity: Soil-strength effects on row-crop yields. Final report, 15:32103 (R;US)

CROSS-LINKING
Utilization of polymer viscoelastic properties in acoustic wave sensor applications, 15:33008 (R;US)

CRUDE OIL
See PETROLEUM

CRUISE MISSILES
CBM modernization: Rail garrison production decision and launch car acquisition should be delayed, 15:32468 (R;US)

CRYOGENIC FLUIDS
Comminution employing liquid nitrogen pretreatments, 15:32040 (RA;US)

CRYOGENICS
Adsorption in cryogenics, 15:32841 (R;FR;In French)
Cryogenic refrigeration. March 1982-March 1990 (A Bibliography from the NTIS data base). Report for March 1982-March 1990, 15:32854 (R;US)
The KSU cryogenic electron-beam ion source, 15:32953 (J;US)

CRYOGENS
See CRYOGENIC FLUIDS

CRYSTAL DEFECTS
Electrolysis at an anthracene crystal/aqueous NO_3^- solution interface: The role of crystal defects, 15:32813 (J;US)

CRYSTAL GROWTH
Roughening phase transition in surface growth, 15:33638 (J;US)

CRYSTAL LATTICES
A generalised Hubbard Hamiltonian: influence of temperature and fractality, 15:33610 (R;BR)
Calculation of ion channeling directions in low symmetry optical materials, 15:32643 (BA;US)
Correlated basis function method for fermions on a lattice: The 1-dimensional Hubbard model, 15:33626 (R;XA)
Phase stability of Ni_3Al_3 under electron irradiation, 15:32580 (BA;US)
Susceptibility of the Potts model in an hierarchical lattice: renormalisation group approach, 15:33613 (R;BR)

CRYSTALS
See also LIQUID CRYSTALS
POLYCRYSTALS
Surface energy anisotropy of diffusion-induced Ni_3Al crystals, 15:32567 (BA;US)

CUMULATIVE EFFECT
See PARTICLE PRODUCTION

CUPRATES
17_{ONMR} study of $YBaa_2Cu_3O_{7-\delta}$, 15:32658 (BA;US)
Effects of deformation on shielding currents in $YBa_2Cu_3O_{7-\delta}$, 15:32650 (BA;US)
Flux-flow resistivity in single crystal $YBa_2Cu_3O_{7-\delta}$, 15:32654 (BA;US)
Hole excitation spectra in cuprate superconductors: A comparative study of single- and multiple-band strong-coupling theories, 15:32681 (J;US)
Neutron scattering studies of magnetic correlations in the layered cuprates, 15:32659 (BA;US)
Observation of thermally activated flux motion inweak link structures, 15:32656 (BA;US)
Pairing in CuO_2 driven by exchange interactions between carriers and localized Cu spins, 15:33633 (BA;US)
Piezochromism: Pressure-induced isomerizations in the tetrachlorocuprate anion in the solid state with various cations, 15:32592 (J;US)
Temperature dependence of the lower critical field of single crystal $YBa_2Cu_3O_{7-gd}$, 15:32655 (BA;US)

CYCLIC ACCELERATORS
See also SYNCHROTRONS
A colloidal solution of Fe_3O_4 crystallites to optically locate the magnetic center of multipole magnets, 15:32934 (R;JP)

CYCLOALKANES
A perfluorocarbon tracer transport and dispersion experiment in the North Sea Ekofisk oil field: Revision, 15:33116 (R;US)

Modification of coal surfaces with methyl radicals, 15:32057 (RA;US)
CYCLOTRON RESONANCE
See also ELECTRON CYCLOTRON-RESONANCE
ERC sources for the production of highly charged ions (invited), 15:32952 (J;US)
CZECH WWR-C REACTOR
See WWR-S-PRAGUE REACTOR

D

D MESONS
See also D MINUS MESONS
D PLUS MESONS
Decays D → Kev, D → K*ev, D → πev in QCD sum rules method, 15:33437 (R;XA)
D MINUS MESONS
Upper limits on $D^{\pm}$ and $B^{\pm}$ decays to two leptons plus $\pi^{\pm}$ or $K^{\pm}$, 15:33419 (J;US)
D PLUS MESONS
Upper limits on $D^{\pm}$ and $B^{\pm}$ decays to two leptons plus $\pi^{\pm}$ or $K^{\pm}$, 15:33419 (J;US)
D PLUS RESONANCES
See D MESONS
D RESONANCES
See CHARMED MESONS
D* PLUS RESONANCES
See BARYONS
D* ZERO RESONANCES
See BARYONS
D*-2010 MESONS
Measurement of D^* production in jets from $\bar{p}p$ collisions at $\sqrt{s}$ =1.8 TeV, 15:33413 (J;US)
D*RESONANCES
See BARYONS
D-1285 RESONANCES
See F1-1285 MESONS
D-1865 RESONANCES
See D MESONS
D-2007 RESONANCES
See D*-2010 MESONS
DARK MATTER
See NONLUMINOUS MATTER
DARK REPAIR
See BIOLOGICAL REPAIR
DATA BASE MANAGEMENT
Natural language interfaces to data-base systems. Final report, April-August 1988, 15:33857 (R;US)
Nuclear Computerized Library for Assessing Reactor Reliability (NUCLARR): Summary description: Volume 1, Revision 1, 15:32416 (R;US)
Supervisory Control and Data Acquisition (SCADA). January 1975-December 1989 (A Bibliography from the COMPENDEX data base). Report for January 1975-December 1989, 15:33862 (R;US)
Unifying the object-oriented paradigm with semantic data models, 15:33838 (R;US)
DATA TRANSMISSION SYSTEMS
Technical publication transfer test with Boeing Computer Services: MIL-M-28001 (SGML) and MIL-D-28000 Class I (IGES): Quick short test report, 15:33855 (R;US)
DAYLIGHTING
Daylighting as a passive solar energy option: an assessment of its potential in non-domestic buildings, 15:32478 (R;GB)
DEBRIS (NUCLEAR)
See FISSION PRODUCTS
DECALSO
See ION EXCHANGE MATERIALS
DECISION MAKING
A decision-analysis process to support verification technology research and development, 15:32528 (R;US)
DEFENSE
See NATIONAL DEFENSE
DEFORMED NUCLEI
Mass systematics for A=29–44 nuclei: The deformed A~32 region, 15:33591 (J;US)
DEGRADATION (ENERGY)
See ENERGY LOSSES
DEHYDROGENASES
See OXIDOREDUCTASES
DELAWARE
Proximity of Delaware sanitary landfills to wetlands and deep-water habitats: Data on individual landfills. Part B, 15:33151 (R;US)
DELAYED RADIATION INJURIES
See RADIATION INJURIES
DELTA BARYONS
See also DELTA-1232 BARYONS
DELTA-1600 BARYONS
Nucleon and isobar properties in a relativistic Hartree-Fock calculation with vector Richardson potential and various radial forms for scalar mass terms, 15:33569 (R;BR)
DELTA RESONANCES (MESON)
See MESONS
DELTA-1232 BARYONS
The calculation of the quark distribution amplitude of the $\Delta^{3/2+}(1232)$ respectively the $\Delta^{1/2-}(1600)$ by means of the QCD sum rules for the determination of the N→Δ transition form factor at $Q^2 \simeq 10$ GeV^2, 15:33426 (R;DE;In German)
DELTA-1236 RESONANCES
See DELTA-1232 BARYONS
DELTA-1600 BARYONS
The calculation of the quark distribution amplitude of the $\Delta^{3/2+}(1232)$ respectively the $\Delta^{1/2-}(1600)$ by means of the QCD sum rules for the determination of the N→Δ transition form factor at $Q^2 \simeq 10$ GeV^2, 15:33426 (R;DE;In German)
DELTA-1650 RESONANCES
See DELTA-1600 BARYONS
DELTA-2850 RESONANCES
See DELTA BARYONS
DENSITY (PLASMA)
See PLASMA DENSITY
DEOXYCYTIDINURIA
See URINE
DEOXYPENTOSE NUCLEIC ACID
See DNA
DEOXYRIBONUCLEIC ACID
See DNA
DEPARTMENT OF DEFENSE
See US DOD
DEPLETION (ISOTOPIC)
See ISOTOPE SEPARATION
DEPLETION (NUCLEAR FUELS)
See BURNUP
DEPOSITS (GEOLOGICAL)
See GEOLOGIC DEPOSITS
DERMATITIS
Health-hazard evaluation report HETA 87-075-1988, American Cyanamid, Wallingford, Connecticut, 15:33074 (R;US)
DESERTRON
See SUPERCONDUCTING SUPER COLLIDER
DESIGN BASIS ACCIDENTS
Reactivity accidents: A reassessment of the design-basis events, 15:32402 (RA;US)
DESOXYRIBONUCLEIC ACID
See DNA
DESULFOVIBRIO
Development of a new fluorometric detection test of sulfatoreducing bacteria type Desulfovibrio. Laboratory evaluation of chemical control of bacteria activity in biocorrosion, 15:32545 (R;FR;In French)
DESULFURIZATION
Reducing sulphur in coke, 15:32068 (R;XE)
DETECTION (NUCLEAR EXPLOSIONS)
See NUCLEAR EXPLOSION DETECTION
DETECTORS (RADIATION)
See RADIATION DETECTORS

DETONATIONS
Graphical analysis of barrel-tamped explosively accelerated flyer plates, 15:33027 (R;US)

DETONATORS
A transformer coupled semiconductor bridge igniter for low voltage ignition from a high voltage source, 15:33025 (R;US)

DEUTERIUM
Thermal conductivity of condensed D-T and T_2, 15:32674 (J;US)
Trapping of deuterium at damage in graphite, 15:32710 (R;US)

DEUTERIUM IONS
Testing of a H_2^+-enriched ion source for deuterium simulation, 15:33349 (J;US)

DEUTERIUM TARGET
Deuterium interactions with ion-implanted oxygen in Cu and Au, 15:33344 (BA;US)
Forward scattering of a proton from a $J=1$ nucleus: Selection rules for flipping the spin of the target by two units, 15:33580 (J;US)
Muon reactivation in muon-catalyzed *d-t* fusion from accurate *p*-He^+ stripping and excitation cross sections, 15:33368 (J;US)

DEUTERIUM TRITIDE
Thermal conductivity of condensed D-T and T_2, 15:32674 (J;US)

DEUTERIUM TRITIDES
See DEUTERIUM TRITIDE

DEUTERON-DEUTERON INTERACTIONS
See DEUTERIUM TARGET

DEUTERONS
Precise extractions of the x and Q^2 dependence of $R = \sigma_L/\sigma_T$, F_{2p}, F_{2d}, and $F_{2n}/_{2p}$ from a combined analysis of SLAC [Stanford Linear Accelerator Center] deep inelastic electron scattering experiments, 15:33433 (R;US)

DEVELOPING COUNTRIES
See also NIGERIA
PAKISTAN
VENEZUELA
Renewable-resource management in agriculture. World Bank operations evaluation study, 15:32455 (R;US)

DEWATERING EQUIPMENT
Sludge dewatering: Sewage and industrial wastes. January 1978-December 1989 (A Bibliography from Pollution Abstracts). Report for January 1978-December 1989, 15:33133 (R;US)

DEXTRIN
Neutron diffraction of alpha, beta and gamma cyclodextrins: Hydrogen bonding patterns, 15:33200 (J;US)

DIAMONDS
Epitaxial growth of diamond films on Si(111) at room temperature by mass-selected low-energy C^+ beams, 15:32672 (J;US)
Fourier-transform and continuous-wave EPR studies of nickel in synthetic diamond: Site and spin multiplicity, 15:32775 (J;US)

DIAPHRAGMS (THERMONUCLEAR DEVICE)
See LIMITERS

DICHLOROMETHANE
See METHYLENE CHLORIDE

DIELECTRIC MATERIALS
Deposition of dielectric optical coatings: A microstructural study of the deposited layers and interfaces, 15:32726 (BA;US)
Parity violation and superconductivity in doped Mott insulators, 15:33654 (R;XA)
The chemistry and physics of nonlinear optical materials: A new look at an old field, 15:32994 (BA;US)

DIELECTRICS
See DIELECTRIC MATERIALS

DIESEL ENGINES
Ceramic port shields cast in an iron engine head, 15:32522 (J;US)
Ceramic valve development for heavy-duty low heat rejection diesel engines, 15:32521 (J;US)
Diesels in the occupational environment: An environmental perspective, 15:33073 (R;US)
Engine turbochargers and superchargers. January 1983-January 1990 (A Bibliography from the COMPENDEX data base). Report for January 1983-January 1990, 15:32518 (R;US)
Technical and economic evaluation of diesel engine with oxygen enrichment and water injection, 15:32502 (R;US)

DIESEL FUELS
Technical and economic evaluation of diesel engine with oxygen enrichment and water injection, 15:32502 (R;US)

DIESEL OIL (FRACTION)
See DIESEL FUELS

DIFFERENTIAL EQUATIONS
See also PARTIAL DIFFERENTIAL EQUATIONS
An existence theorem for periodic solutions and applications to some third order nonlinear differential equations, 15:33676 (R;XA)
An instability theorem for a certain sixth order differential equation, 15:33670 (R;XA)
Oscillatory and nonoscillatory behaviour of solutions of an equation alternately of retarded and advanced type, 15:33684 (R;XA)
Periodic solutions of certain fifth order differential equations, 15:33685 (R;XA)
Potential performance of methods for parallelism across time in ODEs, 15:33844 (R;US)
Uniform dissipative solutions for some fourth order nonlinear differential equations, 15:33675 (R;XA)

DIFFUSION
A unified theory of radon transport in porous media: Model benchmark and soil parameter evaluations: Project annual report, 15:33140 (R;US)
Numerical simulations of the mountain iron tracer data, 15:33061 (R;US)
Parameterization of aerosol scavenging in a convective cloud model, 15:33105 (R;US)

DIGESTER GAS
See METHANE

DIGITAL FILTERS
Applications of modern filtering to accelerators, 15:32913 (BA;US)

DIMETHYLBENZENES
See XYLENES

DIMETHYLPHENOLS
See XYLENOLS

DINING HALLS
See RESTAURANTS

DIODE TRANSISTORS
See TRANSISTORS

DIODE TUBES
Operation of a bidirectional voltage-dividing bremsstrahlung diode, 15:32918 (J;US)

DIODES (SEMICONDUCTOR)
See SEMICONDUCTOR DIODES

DIOXIN
Ambient concentrations of PCDDs/PCDFs (polychlorinated dibenzodioxins/dibenzofurans) in the South Coast Air Basin. Final report, 1987-1990, 15:33068 (R;US)
Analysis of mutagenic activity of biohazardous organics in Kanawha River sediments. Technical completion report, 15:33181 (R;US)
Comparison of serum levels of 2,3,7,8-tetrachlorodibenzo-p-dioxin with indirect estimates of Agent Orange exposure among Vietnam veterans. Final report, 15:33235 (R;US)
NIOSH (National Institute for Occupational Safety and Health) testimony on dioxin by J. D. Millar on November 9, 1983, 15:33238 (R;US)

DIRAC EQUATION
Dirac's equation as a geodesic in Riemann space, 15:33664 (R;BR)

DIRAC MATRICES
See DIRAC OPERATORS

DIRAC OPERATORS
On the ζ-function regularization of chiral Jacobians for singular Dirac operators, 15:33663 (R;BR)

DIRECTED-ENERGY WEAPONS
Onboard detection of intrinsic Lyα radiation from a neutral particle beam, 15:33041 (R;US)

DISSOLVED OXYGEN
See OXYGEN

DISTRICT HEATING
Analysis of economics and market for urban nuclear heating in China, 15:32330 (R;CN;In English and Chinese)
DISTURBANCES
See also SUDDEN IONOSPHERIC DISTURBANCE
Determination of calibration constants for perturbing objects of cavity resonators, 15:32879 (R;BR;In Portuguese)
DNA
See also RECOMBINANT DNA
Fluorescence line narrowing spectrometry: A versatile tool for the study of chemically initiated carcinogenesis, 15:33197 (BA;US)
v-src induces clonal sarcomas and rapid metastasis following transduction with a replication-defective retrovirus, 15:33207 (J;US)
DNA ADDUCTS
Enhanced fluorescence and Raman analysis of DNA-adduct products, 15:32793 (BA;US)
DNA POLYMERASES
Fidelity of DNA polymerases in DNA amplification, 15:33204 (J;US)
DOLOMITE
Basic data report for drillhole H-12 (Waste Isolation Pilot Plant-WIPP), 15:32236 (R;US)
DOPED MATERIALS
High-temperature defect structure of Nb-doped $LaCrO_3$, 15:32669 (J;US)
Improving the performance of $InAs_{1-x}Sb_x$/InSb infrared detectors grown by metal organic chemical vapor deposition, 15:32711 (R;US)
Parity violation and superconductivity in doped Mott insulators, 15:33654 (R;XA)
DORMITORIES
See RESIDENTIAL BUILDINGS
DOUBLE BETA DECAY
Double-beta decay, 15:33536 (J;US)
Present status of $\beta\beta$ decay measurements, 15:33404 (RA;JP)
DOUBLET-3 DEVICE
A study on the heating and diagnostic of a tokamak plasma by electromagnetic waves of the electron cyclotron range of frequencies, 15:33763 (R;JP;In Japanese)
DOW GASIFICATION PROCESS
Dow Syngas Project Monitoring Review Committee Meeting Report. Held in Plaquemine, Louisiana on September 14, 1989, 15:32073 (R;US)
DOWEX
See ORGANIC ION EXCHANGERS
DOWTHERM
See BIPHENYL
DRIFT (PLASMA)
See PLASMA DRIFT
DRILL BITS
Real-time bit-wear estimation using surface-vibration signals. Phase 1, 15:33007 (R;US)
DRILL HOLES
See BOREHOLES
DRILL SHIPS
See OFFSHORE PLATFORMS
DRILLING FLUIDS
Lost circulation technology development projects, 15:32299 (R;US)
DRILLING MUD
See DRILLING FLUIDS
DRILLING PLATFORMS
See OFFSHORE PLATFORMS
DRINKING WATER
Drinking water: Safeguards are not preventing contamination from injected oil and gas wastes, 15:32153 (R;US)
Ultratrace determination of formaldehyde in potable water, 15:33256 (BA;US)
DROPLETS
Delay of explosive vaporization in pulsed laser-heated droplets, 15:33112 (J;US)
DRYOUT
Validation of film dryout model in a three-fluid code FIDAS, 15:32870 (R;JP)
DUAL-PURPOSE POWER PLANTS
Grid-interconnection requirements for small cogeneration systems - Appendix. Final report, September 1985-December 1987, 15:32517 (R;US)
Grid-interconnection requirements for small cogeneration systems. Final report, September 1985-December 1987, 15:32516 (R;US)
DURENE
Inhibition of retrogressive reactions in coal/petroleum coprocessing: Quarterly technical progress report, December 1, 1989–February 28, 1990, 15:32053 (R;US)
DUSTS
See also COSMIC DUST
Improved emission factors for fugitive dust from Western surface coal mining sources. Volume 2. Emission factors, 15:32111 (R;US)
Improved emission factors for fugitive dust from Western surface-coal-mining sources. Volume 1. Sampling methodology and test results, 15:32110 (R;US)
DYMAC SYSTEM
See NUCLEAR MATERIALS MANAGEMENT
PLUTONIUM
DYNAMIC LOADS
See also WIND LOADS
The prediction of loads on penetrators into rock via the spherical cavity expansion approximation, 15:33021 (R;US)
DYNAMIC MATERIALS ACCOUNTABILITY SYSTEM
See NUCLEAR MATERIALS MANAGEMENT
PLUTONIUM
DYNAMICS
Perturbed period-doubling bifurcation. I. Theory, 15:33719 (J;US)
DYNAMICS (BEAM)
See BEAM DYNAMICS

E

E-1422 RESONANCES
See F1-1420 MESONS
EARLY RADIATION INJURIES
See RADIATION INJURIES
EARTH ATMOSPHERE
See also EARTH MAGNETOSPHERE
Determination of airborne organics by direct sampling mass spectrometry, 15:33050 (R;US)
EARTH MAGNETOSPHERE
Solar-Geophysical Data Number 545, January 1990. Part 1 (prompt reports). Data for December, November 1989, and late data, 15:33313 (R;US)
EARTH PENETRATORS
The prediction of loads on penetrators into rock via the spherical cavity expansion approximation, 15:33021 (R;US)
EARTHQUAKES
SLAC [Stanford Linear Accelerator Center] site geology, ground motion and some effects of the October 17, 1989 earthquake, 15:33277 (R;US)
EBFA
See ELECTRON BEAM FUSION ACCELERATOR
ECCS
See also HIGH PRESSURE COOLANT INJECTION
Evaluation report on CCTF Core-II reflood test C2-AA2 (Run 58): Investigation of downcomer injection effects, 15:32373 (R;JP)
ECONOMIC GROWTH
Sustainable development, 15:32451 (R;NO)
ECR
See ELECTRON CYCLOTRON-RESONANCE
EFFLUENTS (CHEMICAL)
See CHEMICAL EFFLUENTS
EFFLUENTS (GASEOUS)
See GASEOUS WASTES

EFFLUENTS (LIQUID)
See LIQUID WASTES
EFFLUENTS (RADIOACTIVE)
See RADIOACTIVE EFFLUENTS
EFFUSION
See DIFFUSION
EHF RADIATION
See MICROWAVE RADIATION
EINSTEIN FIELD EQUATIONS
A comment on anisotropic spheres admitting one parameter group of conformal motions, 15:33671 (R;XA)
EINSTEIN GRAVITATION THEORY
See GENERAL RELATIVITY THEORY
EINSTEIN-DE SITTER MODEL
See COSMOLOGICAL MODELS
ELASTIC PROPERTIES
See ELASTICITY
ELASTICITY
Utilization of polymer viscoelastic properties in acoustic wave sensor applications, 15:33008 (R;US)
ELASTOMERS
Plastics and elastomers: Ozone degradation. January 1973-December 1989 (A Bibliography from the Rubber and Plastics Research Association data base). Report for January 1973-December 1989, 15:32708 (R;US)
ELECTRIC ARCS
Sources of multiply charged ions for heavy-ion fusion, 15:33801 (J;US)
ELECTRIC BRIDGES
A transformer coupled semiconductor bridge igniter for low voltage ignition from a high voltage source, 15:33025 (R;US)
ELECTRIC COILS
Cast coil transformer fire susceptibility and reliability study, 15:32880 (R;US)
ELECTRIC CONDENSERS
See CAPACITORS
ELECTRIC CONDUCTIVITY
See also SUPERCONDUCTIVITY
Encoding of the Burgess metal electrical resistivity model into SESAME format and its adaptation to the metal nickel, 15:32548 (R;US)
ELECTRIC CONTACTS
Au-Ge-Ni-Ti ohmic contacts on gallium arsenide, 15:32537 (R;US)
ELECTRIC FIELDS
See also COULOMB FIELD
Initial studies of electric field effects on ceramic powder formation in flames, 15:32860 (R;US)
ELECTRIC POWER
See also HYDROELECTRIC POWER
Natural gas requirements for electricity generation through 2000: Can the natural gas industry meet them?: Volume 1: Final report, 15:32174 (R;US)
Practical superconductor development for electrical power applications: Annual report for FY 1989, 15:32878 (R;US)
Technology choice in a least-cost expansion analysis framework: The impact of gas prices, planning horizon, and system characteristics, 15:32318 (R;US)
ELECTRIC POWER SYSTEMS
See POWER SYSTEMS
ELECTRIC PULSES
See PULSES
ELECTRIC RESISTIVITY
See ELECTRIC CONDUCTIVITY
ELECTRIC SPARKS
Simulation of the build-up phase of a high voltage low pressure gas discharge using Monte-Carlo-methods, 15:32975 (R;DE;In German)
ELECTRIC UTILITIES
Impact of automated feeder reconfiguration on capacity utilization at the Athens Utilities Board, 15:32429 (R;US)
Introduction to the Argonne Utility Simulation (ARGUS) model, 15:32470 (R;US)
Measurements at Aeroe Windmill park, 15:32307 (R;DK;In Danish)
Practical ice thermal storage applications, 15:32490 (B;US)
Reliability differentiated pricing of electricity service, 15:32436 (R;US)
Technology choice in a least-cost expansion analysis framework: The impact of gas prices, planning horizon, and system characteristics, 15:32318 (R;US)
The Argonne Utility Simulation model: An analysis tool for evaluating energy and environmental strategies, 15:32097 (R;US)
ELECTRIC-POWERED VEHICLES
Application of ultracapacitors in electric vehicle propulsion systems, 15:32523 (R;US)
Federal regulations needing amendment to stimulate the production and introduction of electric/solar vehicles. A report to Congress, January 1990, 15:32524 (R;US)
Initial testing of two DEMI [Driesbach Electromotive Inc.] Model 4E zinc-air rechargeable cells, 15:32439 (R;US)
Laboratory testing of chloride 3ET205 6 volt traction battery, 15:32438 (R;US)
ELECTRICAL CONDUCTIVITY
See ELECTRIC CONDUCTIVITY
ELECTRICAL ENGINEERING
Center for Electronics and Electrical Engineering Technical Progress Bulletin covering Center programs, July to September 1989, with 1990 CEEE events calendar, 15:32466 (R;US)
ELECTRICAL INSULATION
The insulation irradiation test program for the Compact Ignition Tokamak, 15:33807 (R;US)
ELECTRICAL PROPERTIES
See also ELECTRIC CONDUCTIVITY
Multichip packaging technology with laser-patterned interconnects, 15:32714 (R;US)
ELECTRICAL RESISTANCE
See ELECTRIC CONDUCTIVITY
ELECTRICAL RESISTIVITY
See ELECTRIC CONDUCTIVITY
ELECTRICITY
The earth's electrical environment: Studies in geophysics, 15:33052 (R;US)
ELECTRODYNAMICS
See also QUANTUM ELECTRODYNAMICS
Limits on a Lorentz- and parity-violating modification of electrodynamics, 15:33524 (J;US)
ELECTROKINETICS
See ELECTRODYNAMICS
ELECTROLYTES
Physical modeling of bubble phenomena, electrolyte flow and mass transfer in simulated advanced Hall cells: Final report, 15:32504 (R;US)
ELECTROLYTIC CELLS
Self-discharge study of Li-alloy/FeS_2 thermal cells, 15:32440 (R;US)
ELECTROMAGNETIC FIELDS
Chronobiological effects of electric fields, 15:33260 (BA;US)
Electromagnetic computations for fusion devices, 15:33731 (R;US)
Extremely low frequency electromagnetic fields: The question of cancer, 15:33259 (B;US)
Investigation of effects of 60-Hz electric and magnetic fields on operant and social behavior and on the neuroendocrine system of nonhuman primates: Annual report, 15:32435 (R;US)
ELECTROMAGNETIC INTERACTIONS
See also PHOTON-PHOTON INTERACTIONS
PHOTOPRODUCTION
Completely ununified standard model, 15:33469 (J;US)
Consistent three-nucleon forces in the nuclear many-body problem, 15:33443 (R;FR)
ELECTROMAGNETIC PULSES
Numerical modeling tools for transient electromagnetic problems, 15:33036 (R;US)
ELECTROMAGNETIC RADIATION
See also BREMSSTRAHLUNG
ELECTROMAGNETIC PULSES

GAMMA RADIATION
INFRARED RADIATION
MICROWAVE RADIATION
Propagation of electromagnetic radiation in a random field of gravitational waves and space radio interferometry, 15:33673 (R;XA)

ELECTROMAGNETIC WAVES
See ELECTROMAGNETIC RADIATION

ELECTROMETALLURGY
Physical modeling of bubble phenomena, electrolyte flow and mass transfer in simulated advanced Hall cells: Final report, 15:32504 (R;US)

ELECTRON ACCEPTOR
See ELECTRONS

ELECTRON BEAM FUSION ACCELERATOR
Dosimetry considerations for the high-energy photon/electron environment of HERMES III: Implications for experiments and modeling, 15:32937 (R;US)

ELECTRON BEAMS
Dosimetry considerations for the high-energy photon/electron environment of HERMES III: Implications for experiments and modeling, 15:32937 (R;US)
Long ion chamber systems for the SLC (Stanford linear collider), 15:32947 (BA;US)
Measurements of Smith–Purcell radiation, 15:32997 (J;US)
Pulse power considerations for the generation of 45 μs, 200 keV electron beams for CO_2 lasers, 15:33827 (BA;US)
Simulation of radial expansion of an electron beam injected into a background plasma, 15:32925 (R;US)
Simulation of relativistic electron and ion flows, 15:33339 (RA;CS)
The KSU cryogenic electron-beam ion source, 15:32953 (J;US)
Time-dependent degradation of an ion-focused ATA beam, 15:32926 (BA;US)
X-ray preionization technology for high pressure gas discharge lasers, 15:32890 (BA;US)

ELECTRON CONFIGURATION (ATOMS)
See ELECTRONIC STRUCTURE

ELECTRON CYCLOTRON MASERS
See MICROWAVE AMPLIFIERS

ELECTRON CYCLOTRON-RESONANCE
Electron cyclotron resonance ion source frequency scaling and radial confinement in a quadrupole magnetic field, 15:32954 (J;US)

ELECTRON DONOR
See ELECTRONS

ELECTRON GAS
Two-state one-dimensional spinless Fermi gas, 15:33642 (J;US)

ELECTRON MICROSCOPES
$\delta^2 - Y_2Si_2O_7$ structure confirmed by processing and simulaton of atomic-resolution images, 15:32636 (BA;US)

ELECTRON REACTIONS
Quasielastic electron scattering and Coulomb sum rule in ^{4}He, 15:33417 (J;US)
Ad hoc Coulomb corrections to the radiation tail, 15:33587 (J;US)

ELECTRON SOURCES
Pulse power considerations for the generation of 45 μs, 200 keV electron beams for CO_2 lasers, 15:33827 (BA;US)

ELECTRON SPECTROMETERS
Efficient energy spectrometer for charged particle detection in surface studies, 15:32982 (J;US)

ELECTRON-ION COLLISIONS
The theory of electron-ion collisions: The role of doubly excited states, 15:33328 (R;US)

ELECTRON-MOLECULE COLLISIONS
Selection rules in resonance electron scattering from adsorbed molecules, 15:33649 (J;US)
Variational expressions for first-order properties involving continuum wave functions, 15:33373 (J;US)

ELECTRON-POSITRON INTERACTIONS
Hadron production in a fireball radiation model for electron-positron collisions, 15:33428 (R;BR)
Heavy quarkonium production close to neutral gauge E_6 bosons in e^+e^- annihilation, 15:33435 (R;XA)
Measurement of the B^0-meson lifetime, 15:33416 (J;US)
Micropolyelectrons as possible sources of the anomalous positron peaks in heavy-ion reactions, 15:33566 (R;US)
Prompt leptons from the decays of heavy quarks in the e^+e^- annihilation at energies of 35 and 43 GeV, 15:33408 (R;DE;In German)
QED corrected extra Z boson effects at e^+e^- colliders, 15:33436 (R;XA)
Search for long-lived massive neutrinos in Z decays, 15:33415 (J;US)

ELECTRON-PROTON INTERACTIONS
On the detection of the radiation amplitude zero in $e^{\pm}p$ collisions, 15:33467 (J;US)

ELECTRONIC CIRCUITS
Predicting switched-bias response from steady-state irradiations, 15:33042 (R;US)
Rad-hard electronics development program for SSC liquid-argon calorimeters, 15:32966 (R;US)

ELECTRONIC EQUIPMENT
See also MICROWAVE EQUIPMENT
Emerging technologies in electronics and their measurement needs. Second edition, 15:32465 (R;US)
Group fellowship training in nuclear spectroscopy instrumentation maintenance at the Seibersdorf Laboratories, 15:32983 (J;XA)
Statistical process control for QML [Qualified Manufacturer's List] radiation hardness assurance, 15:32881 (R;US)

ELECTRONIC STRUCTURE
X-ray absorption spectroscopy: EXAFS [Extended X-ray Absorption Fine Structure] and XANES [X-ray Absorption Near Edge Structure]: A versatile tool to study atomic and electronic structure of materials, 15:33327 (R;US)

ELECTRONICS (QUANTUM)
See QUANTUM ELECTRONICS

ELECTRONS
Electron acceleration by an electromagnetic wave, 15:33340 (RA;JP)
Experimental studies of V_pxB electron linear accelerator, 15:32909 (RA;JP)
Numerical simulation of multi-EM-beam electron accelerator, 15:32924 (RA;JP)
Resonance of the one-dimensional electron transmission above a quantum well with dissipation, 15:33645 (J;US)
Single-electron charging effects: Technical progress report, 15:33618 (R;US)
The electron: Its properties and reactions, 15:33343 (BA;US)
Track models and radiation chemical yields, 15:32832 (BA;US)
Transport of fast electrons through thin foils, 15:33597 (J;US)

ELECTROSTATIC LENSES
SIMION PC/PS2 electrostatic lens design program, 15:33361 (J;US)

ELECTROWEAK MIXING ANGLE
See WEINBERG ANGLE

ELECTROWEAK MODEL
See WEINBERG-SALAM GAUGE MODEL

ELECTROWINNING
See ELECTROMETALLURGY

ELEMENTARY PARTICLES
See also ANTIPARTICLES
BEAUTY PARTICLES
CHARM PARTICLES
HADRONS
LEPTONS
MASSLESS PARTICLES
Higher order equations of motion, 15:33430 (R;BR)
Physics at the 100 GeV mass scale: Proceedings, 15:33398 (R;US)

ELEMENTS
See also METALS
TRANSURANIUM ELEMENTS
Molecular equilibrium with condensation, 15:33320 (J;US)

ELLIPSOMETERS
Two-channel polarization modulation ellipsometer, 15:32998 (J;US)

EMBRITTLEMENT
Power reactor embrittlement data base, 15:32551 (RA;US)

EMC EFFECT
Phenomenological study of the polarized lepto production, 15:33448 (R;FR)
EMERGENCY CORE COOLING SYSTEM
See ECCS
EMITTANCE (BEAM)
See BEAM EMITTANCE
EMP
See ELECTROMAGNETIC PULSES
EMPLOYEES
See PERSONNEL
ENDANGERED SPECIES
Endangered species program, Naval Petroleum Reserves in California: Annual report FY89, 15:32152 (R;US)
ENEL-4 REACTOR
Maintaining leak tightness capability of Caorso BWR containment, 15:32384 (RA;US)
ENERGY CONSERVATION
Maintenance and energy conservation - a pratical guide for energy managers and maintenance engineers, 15:32498 (R;FR;In French)
ENERGY CONSUMPTION
Defense Energy Information System (DEIS). Directive, 15:33861 (R;US)
ENERGY CONVERSION
See also SOLAR ENERGY CONVERSION
Chlorophyll photochemistry in microheterogeneous media, 15:32279 (R;US)
ENERGY DISSIPATION
See ENERGY LOSSES
ENERGY LOSSES
Long ion chamber systems for the SLC (Stanford linear collider), 15:32947 (BA;US)
ENERGY OPERATORS
See HAMILTONIANS
ENERGY SOURCES
See also NUCLEAR FUELS
RENEWABLE ENERGY SOURCES
Economics of nonrenewable energy resources, 15:32453 (R;US)
Energy in China, 15:32471 (R;FR;In French)
ENERGY SYSTEMS
See also LIGHTING SYSTEMS
NATURAL GAS DISTRIBUTION SYSTEMS
POWER SYSTEMS
SPACE HVAC SYSTEMS
Residential/Commercial Energy Systems 1983-1984 research status report, September 1984, 15:32176 (R;US)
ENGINEERED SAFETY SYSTEMS
See also CONTAINMENT SYSTEMS
ECCS
CSAU (code scaling, applicability and uncertainty), a tool to prioritize advanced reactor research, 15:32360 (R;US)
ENGLAND
See UNITED KINGDOM
ENHANCED RECOVERY
An evaluation of the known remaining oil resource in the State of Texas: Project on Advanced Oil Recovery and the States, 15:32147 (R;US)
ENRICHMENT (ISOTOPIC)
See ISOTOPE SEPARATION
ENVIRONMENT
See also BIOSPHERE
Air toxics compliance issues and case histories from the Kentucky experience, 15:32450 (BA;US)
FUETAP concrete, 15:32250 (BA;US)
Integrated environmental monitoring at remote ecosystems: First annual report, 15:33124 (R;US)
North Slope investigation report, 15:33135 (R;US)
Pantex Plant site environmental report for calendar year 1988, 15:33062 (R;US)
Potential responses of landscape boundaries to global environmental change, 15:33051 (R;US)
Savannah River Waste Management Program Plan, FY 1990, 15:32212 (R;US)
ENVIRONMENTAL EXPOSURE
Inhalation Toxicology Research Institute annual report, October 1, 1987–September 30, 1988, 15:33223 (R;US)
Inhalation Toxicology Research Institute annual report, October 1, 1988–September 30, 1989, 15:33224 (R;US)
ENVIRONMENTAL IMPACT STATEMENTS
Information dissemination: Cost of mailing environmental impact statement for super collider, 15:32959 (R;US)
ENVIRONMENTAL MATERIALS
Radioactivity survey data in Japan, part 1: Environmental materials, 15:33131 (R;JP)
ENVIRONMENTAL QUALITY
See also AIR QUALITY
WATER QUALITY
Environmental trends. Council on Environmental Quality, 15:32446 (R;US)
ENVIRONMENTAL TEMPERATURE
See AMBIENT TEMPERATURE
ENVIRONMENTAL TRANSPORT
See also RADIONUCLIDE MIGRATION
A unified theory of radon transport in porous media: Model benchmark and soil parameter evaluations: Project annual report, 15:33140 (R;US)
Geohydrology of the 218-W-5 Burial Ground, 200-West Area, Hanford Site, 15:32231 (R;US)
Numerical simulations of the mountain iron tracer data, 15:33061 (R;US)
Parameterization of aerosol scavenging in a convective cloud model, 15:33105 (R;US)
Sediment-water interactions and their effects upon water quality. January 1979-March 1990 (A Bibliography from the NTIS data base). Report for January 1979-March 1990, 15:33186 (R;US)
Urban aerosol transformation and transport modeling. Report for October 1985-October 1988, 15:33091 (R;US)
Urban modeling of organic aerosol source emissions, 15:33047 (R;US)
[Finalization of the International Biospheric Model Validation Study]: Foreign trip report, April 22, 1990–April 28, 1990, 15:33067 (R;US)
EPIPHYSIS (PINEAL GLAND)
See PINEAL GLAND
EPOXIDES
Cast coil transformer fire susceptibility and reliability study, 15:32880 (R;US)
EPOXY COMPOUNDS
See EPOXIDES
EPSILON RESONANCES
See MESONS
EQUATIONS (DIFFERENTIAL)
See DIFFERENTIAL EQUATIONS
EQUATIONS OF STATE
Encoding of the Burgess metal electrical resistivity model into SESAME format and its adaptation to the metal nickel, 15:32548 (R;US)
ERBIUM ADDITIONS
Structure maps and phase stability in $AlTi_3$ alloyed with rare-earth elements, 15:32562 (BA;US)
ERBIUM ALLOYS
See also ERBIUM ADDITIONS
Neutron scattering experiments on $YbXCu_4$ and $ErXCu_4$ (X=Au, Pd, and Ag), 15:32591 (J;US)
ESCHERICHIA COLI
DpnA, a methylase for single-strand DNA in the Dpn II restriction system, and its biological function, 15:33203 (J;US)
Genetic approach to microbial coal desulfurization, 15:32056 (RA;US)
Microbial removal of organic sulfur from coal (bacterial degradation of sulfur containing heterocyclic compounds), 15:32055 (RA;US)
ETA MESONS
Measurement of the two-photon width of the η and η' mesons, 15:33412 (J;US)

ETA PRIME-958 MESONS
Measurement of the two-photon width of the η and η' mesons, 15:33412 (J;US)
ETA-549
See ETA MESONS
ETA-700 RESONANCES
See MESONS
ETA-958 RESONANCES
See ETA PRIME-958 MESONS
ETHANE
New directions for the catalytic conversion of methane. Annual report, January-December 1989, 15:32181 (R;US)
Study of the recombination reaction $CH_3+Ch_3 \rightarrow C_2H_6$: Theory, 15:32274 (BA;US)
Trapping-mediated dissociative chemisorption of ethane on Ir(110)-(1×2), 15:32820 (J;US)
ETHANOL FUELS
CO_2 emissions from production and combustion of fuel ethanol from corn, 15:32270 (R;US)
ETHOCEL
See CELLULOSE
ETHYLENE
Crossover from singular critical to regular classical thermodynamic behavior of fluids, 15:33396 (J;US)
Health-hazard evaluation report HETA 89-007-1983, St. Thomas More Hospital, Canyon City, Colorado, 15:33236 (R;US)
New directions for the catalytic conversion of methane. Annual report, January-December 1989, 15:32181 (R;US)
EURATOM
The new phase for JET and its objective, 15:33765 (RA;GB)
EUROPEAN ATOMIC ENERGY COMMUNITY
See EURATOM
EUROPEAN MUON COLLABORATION EFFECT
See EMC EFFECT
EUROPIUM
Electron spectroscopic investigation of atomic 4d giant resonances for Ba, La and lanthanides, 15:33331 (R;DE;In German)
EUROPIUM COMPLEXES
The extraction of Eu^{+3} from simulated high level liquid waste of nuclear power reactor reprocessing by centrifugal extractors, 15:32195 (R;CN;In Chinese)
EUROPIUM OXIDES
Magnetism, specific heat, and pressure-dependent reistivity of the electron-doped compounds LnMCuO(Ln = Pr,Nd,Sm,Eu,Gd:M = Ce,Th), 15:32641 (BA;US)
EUROPIUM SULFIDES
Study of a magnetic refrigeration cycle by active regeneration between 15 and 4.2 kelvins, 15:32864 (R;FR;In French)
EVAPORATORS
Study of a liquid-vapour contact evaporator, 15:32868 (R;FR;In French)
EVEN-EVEN NUCLEI
See also BARIUM 140
BERYLLIUM 10
CARBON 14
GADOLINIUM 146
HELIUM 4
LEAD 208
MERCURY 192
MOLYBDENUM 100
OXYGEN 16
PLUTONIUM 238
RADIUM 226
RADIUM 228
RADON 220
RADON 222
STRONTIUM 90
THORIUM 230
THORIUM 232
TUNGSTEN 180
TUNGSTEN 182
TUNGSTEN 184
TUNGSTEN 186
URANIUM 234
URANIUM 238
XENON 132
ZIRCONIUM 100
ZIRCONIUM 96
Anharmonicities of vibrational motion in even-even deformed nuclei, 15:33575 (R;FR)
EXCHANGE (HEAT)
See HEAT TRANSFER
EXPERIMENTAL FACILITIES (ACCELERATOR)
See ACCELERATOR FACILITIES
EXPLOSIONS
See also NUCLEAR EXPLOSIONS
Analysis of explosions in hard rocks: The power of discrete element modeling, 15:33039 (R;US)
Literature review of work related to impact of barriers on flammable cloud explosion overpressure: Vapor Barrier Assessment Program, Phase 2, Task 1, 15:32144 (R;US)
Numerical simulation of hypothetical gas explosions in a process unit: Effect of vapor barriers on explosion pressure, 15:32146 (R;US)
EXPLOSIVES
See also CHEMICAL EXPLOSIVES
Condensed-phase kinetic deuterium isotope effects in high-energy phenomena: Mechanistic investigations and relationships. Technical report, January 1975-December 1989, 15:33024 (R;US)
Sensor fusion methodology for remote detection of buried land mines, 15:33034 (R;US)
EXPOSURE (RADIATION DOSES)
See RADIATION DOSES
EXTRACTION (SOLVENT)
See SOLVENT EXTRACTION
EXTRACTION COLUMNS
Study of axial mixing phenomena in pulse columns equipped with crown-disk packing, 15:32196 (R;FR;In French)
EXTREMELY HIGH FREQUENCY RADIATION
See MICROWAVE RADIATION

F

F CODES
Benchmarking of FEMAXI-IV code with fuel irradiation data in power reactors, 15:32320 (R;JP;In Japanese)
F-1540 RESONANCES
See MESONS
F1-1285 MESONS
Study of the doubly radiative decay $J/\psi \rightarrow \gamma\gamma\rho^0$, 15:33423 (J;US)
F1-1420 MESONS
Study of the doubly radiative decay $J/\psi \rightarrow \gamma\gamma\rho^0$, 15:33423 (J;US)
FACILITIES (ACCELERATOR)
See ACCELERATOR FACILITIES
FACILITIES (MILITARY)
See MILITARY FACILITIES
FACILITIES (NUCLEAR)
See NUCLEAR FACILITIES
FACILITIES (STORAGE)
See STORAGE FACILITIES
FALLOUT PARTICULATES
See PARTICLES
FARADAY GENERATORS
See MHD GENERATORS
FAULT TREE ANALYSIS
Living PRAs [probabilistic risk analysis] made easier with IRRAS [Integrated Reliability and Risk Analysis System], 15:32362 (R;US)
FAULT TREE SYSTEMS
See FAULT TREE ANALYSIS
FEDERAL REGION X
Cumulative impact assessment: A case study, 15:32277 (R;US)
North Slope investigation report, 15:33135 (R;US)
FEDERAL REPUBLIC OF GERMANY
Public perception and acceptance of the siting of nuclear waste facilities in seven countries, 15:32218 (R;US)

FERMILAB TEVATRON
The Colliding Beams Sequencer, 15:32950 (BA;US)
The SHOT SUMMARY system for the Tevatron collider, 15:32914 (BA;US)

FERMIONS
See also BARYONS
LEPTONS
QUARKS
Dynamically generated fermionic masses, 15:33479 (BA;US)
Fermions at high temperature, 15:33514 (J;US)
Non-Abelian gauge theory on a finite-element lattice, 15:33522 (J;US)

FERRITIC STEELS
Environmentally assisted cracking in light water reactors, 15:32552 (RA;US)

FERROCENE
Does Marcus-Hush theory really work? Optical studies of intervalence transfer in acetylene-bridged biferrocene monocation at infinite dilution and at finite ionic strengths, 15:32826 (J;US)

FERROMAGNETIC MATERIALS
Systematic approach to critical phenomena by the extended variational method and coherent-anomaly method, 15:33608 (R;BR)
Z(6) model: criticality and break-collapse method, 15:33611 (R;BR)

FIBERS
See also OPTICAL FIBERS
Rapid thermal processing of high temperature superconducting fiber, 15:32616 (R;US)

FIELD EFFECT TRANSISTORS
Lattice-mismatched $In_{0.53}Ga_{0.47}As/In_{0.52}Al_{0.48}As$ modulation-doped field-effect transistors on GaAs: Molecular-beam epitaxial growth and device performance, 15:32772 (J;US)

FIELD THEORIES
See also GENERAL RELATIVITY THEORY
QUANTUM FIELD THEORY
On the relation between the absolute parallelism spaces and spaces having a GL(4) connection, 15:33495 (R;XA)
Topology of singularities and phase diagram of N=2 superconformal field theories, 15:33492 (R;XA)
Trajectories of renormalization group flows on the phase diagram of N=2 superconformal field theories, 15:33491 (R;XA)

FIELD-REVERSED MIRROR REACTORS
US-Japan workshop on field-reversed configurations with steady-state high-temperature fusion plasmas and the 11th US-Japan workshop on compact toroids, 15:33820 (R;US)

FIELDS (ELECTRIC)
See ELECTRIC FIELDS

FIELDS (ELECTROMAGNETIC)
See ELECTROMAGNETIC FIELDS

FIELDS (GRAVITATIONAL)
See GRAVITATIONAL FIELDS

FIELDS (MAGNETIC)
See MAGNETIC FIELDS

FILMS
See also SUPERCONDUCTING FILMS
THIN FILMS
Epitaxial growth of diamond films on Si(111) at room temperature by mass-selected low-energy C^+ beams, 15:32672 (J;US)

FILTERS
See also AIR FILTERS
The application of expandable polystyrene pellets as filter media to controlled filter in a uranium mill, 15:32193 (R;CN;In Chinese)
The certification of the surface density (kg/m_2) of BCR CRM 038 ('fly ash from pulverised coal') comprised in methyl cellulose films simulating dust charged filters. BCR 128, 15:32094 (R;XE)

FINITE ELEMENT METHOD
Applications of mixed Petrov-Galerkin finite element methods to transient and steady state creep analysis, 15:33709 (R;BR)
Dual and primal mixed Petrov-Galerkin finite element methods in heat transfer problems, 15:33711 (R;BR)
Finite element analysis of nonlinear creeping flows, 15:33710 (R;BR)

FIREDAMP
See METHANE

FIRES
A parametric investigation of electrical effects on aerosol scavenging by droplets over large fires, 15:33108 (R;US)
Parameterization of aerosol scavenging in a convective cloud model, 15:33105 (R;US)

FIRST WALL
Controlled thermonuclear fusion: research on magnetic fusion: Experimental hall and remotely operated manipulators. Concept of a reactor, and his environmental impact, 15:33821 (R;CH;In French)
Modeling of runaway electron damage for the design of tokamak plasma facing components, 15:33822 (R;US)
The effects of chromium and titanium gettering on the operation of the Advanced Toroidal Facility, 15:33806 (R;US)

FISHES
Examination of the impact of radioactive liquid effluent releases from the Rancho Seco Nuclear Power Plant, 15:33190 (J;US)
Toxicity bioassays: Water pollution effects on aquatic animals and plants. June 1986-February 1990 (A bibliography from the Selected Water Resources Abstracts data base). Report for June 1986-February 1990, 15:33183 (R;US)

FISSION NEUTRONS
Delayed neutron data and group parameters for 43 fissioning systems, 15:32334 (J;US)
JANUS neutron irradiation of a mouse cell line containing a shuttle vector plasmid, 15:33221 (R;US)

FISSION PRODUCT RELEASE
Wind tunnel tests on the evaluation of interferences due to buildings on the propagation of radioactive materials after release from nuclear facilities. Report and annex, 15:33046 (R;DE;In German)

FISSION PRODUCTS
Fission product measurement methods. Present state of knowledge, 15:33565 (R;FR;In French)
Fission product release as a function of chemistry and fuel morphology, 15:32345 (R;US)

FISSIONABLE MATERIALS MANAGEMENT
See NUCLEAR MATERIALS MANAGEMENT

FISSURED FORMATIONS
See FRACTURED RESERVOIRS

FLAMES
Initial studies of electric field effects on ceramic powder formation in flames, 15:32860 (R;US)
Modelling of flamelet surface-to-volume ratio in turbulent premixed combustion, 15:32861 (R;US)

FLASKS
See CASKS

FLOW (FLUID)
See FLUID FLOW

FLUE GAS
Acoustic agglomeration of power plant fly ash for environmental and hot gas cleanup: Final report: Revised Version, 15:32311 (R;US)
Corona enhanced absorption of SO_2/NO_x, 15:32091 (RA;US)
Development of operation support system for flue-gas desulfurization plant, 15:32315 (R;JP)
Flue gas conditioning applied to fabric filtration, 15:32095 (BA;US)
Simultaneous SO_x/NO_x control: Technical report, April 1, 1987–March 31, 1988 including Quarterly technical progress report, January–March 1988, 15:32310 (R;US)
The importance of clean coal technologies to reduce power plant emissions, 15:32312 (RA;US)

FLUID FLOW
See also COMPRESSIBLE FLOW
CRITICAL FLOW
HYPERSONIC FLOW
LIQUID FLOW
TURBULENT FLOW
Complex cavities: Are two dimensions sufficient for computation?, 15:33391 (J;US)
FRAC-UNIX theory and user's manual, 15:32298 (R;US)

Listening to turbulence: An example of scientific audiolization, 15:33388 (R;US)
Planform selection in rotating convection, 15:33392 (J;US)

FLUIDIZED BED
See FLUIDIZED BEDS

FLUIDIZED BED REACTORS
Coupled biological downflow fluid bed reactor treatment of synfuels wastewater, 15:33189 (BA;US)

FLUIDIZED BEDS
Mechanics/heat-transfer relation for particulate materials: Quarterly report, 15:32114 (R;US)

FLUIDIZED-BED COMBUSTION
Waste Management: Final technical report, April 1, 1987–March 31, 1988 including Quarterly technical progress report, January–March 1988, 15:32090 (R;US)

FLUIDIZED-BED COMBUSTORS
Fluidized bed combustion: Mechanical systems and chemical processes. December 1973-March 1990 (A Bibliography from the NTIS data base). Report for December 1973-March 1990, 15:32875 (R;US)
Fluidized-bed combustion: Air pollution analyses. November 1970-March 1990 (A Bibliography from the NTIS data base). Report for November 1970-March 1990, 15:33097 (R;US)
Fluidized-bed combustion: Air-pollution abatement. September 1972-March 1990 (A Bibliography from the NTIS data base). Report for September 1972-March 1990, 15:33098 (R;US)

FLUIDS
See also CRYOGENIC FLUIDS
DRILLING FLUIDS
GASES
LIQUIDS
Crossover from singular critical to regular classical thermodynamic behavior of fluids, 15:33396 (J;US)
Dispersion relations for gravity waves in a deep fluid: Second sound in a stormy sea, 15:33395 (J;US)
Renormalized equations for linear transport in stochastic media, 15:33393 (J;US)
Rigorous bounds on the fluid permeability: Effect of polydispersivity in grain size, 15:33389 (J;US)
Turbulent energy at accelerating and shocked interfaces, 15:33390 (J;US)

FLUORESCENCE SPECTROSCOPY
Ultrafast time-resolved fluorescence spectroscopy, 15:32801 (J;US)

FLUORIMETRY
See FLUORESCENCE SPECTROSCOPY

FLUORINE IONS
Angular distribution of Auger electrons and photons in resonant transfer and excitation in collisions of ions with light targets, 15:33364 (J;US)

FLUX (MAGNETIC)
See MAGNETIC FLUX

FLUX (METALLURGY)
See METALLURGICAL FLUX

FLUX (NEUTRON)
See NEUTRON FLUX

FLUX JUMPS
See MAGNETIC FLUX

FLUX PINNING
See MAGNETIC FLUX

FLUXOIDS
See MAGNETIC FLUX

FLY ASH
Behavior of phenol and aniline on selected sorbents and energy-related solid wastes, 15:32081 (J;NL)
Biological effects of combined exposure to coal fly ash and nitrogen dioxide, 15:32122 (R;JP;In Japanese)
Encapsulation of mixed radioactive and hazardous waste contaminated incinerator ash in modified sulfur cement, 15:32199 (R;US)
Investigation on the utilization of coal fly ash as amendment to compost for vegetation in acid soil: Progress report, March 16, 1989–April 15, 1990, 15:32092 (R;US)
Reduction of ash sticking in direct coal-fired gas turbine engines, 15:32120 (BA;US)
Special Wasteform Lysimeter Program wasteform characteristics, 15:32214 (R;US)
The certification of the surface density (kg/m_2) of BCR CRM 038 ('fly ash from pulverised coal') comprised in methyl cellulose films simulating dust charged filters. BCR 128, 15:32094 (R;XE)
The removal and control of trace elements in coal and coal wastes, 15:32093 (RA;US)

FOG (SPRAYS)
See SPRAYS

FOILS
High-Speed Microphotographic Laboratory, 15:33013 (BA;US)
High-power Nd:glass laser transmission through optical fibers and its use in acceleration of thin foil targets, 15:32999 (J;US)
Transport of fast electrons through thin foils, 15:33597 (J;US)

FOKKER-PLANCK COEFFICIENTS
See FOKKER-PLANCK EQUATION

FOKKER-PLANCK EQUATION
Convergence of the Langevin simulation for complex Gaussian integrals, 15:33523 (J;US)

FOOD CHAINS
Examination of the impact of radioactive liquid effluent releases from the Rancho Seco Nuclear Power Plant, 15:33190 (J;US)
Hanford Environmental Dose Reconstruction Project: Monthly report, 15:33102 (R;US)

FORESTS
Effects of valley meteorology on forest pesticide spraying, 15:33219 (R;US)
Evaluation of the role of ozone, acid deposition, and other airborne pollutants in the forests of eastern North America. Forest Service general technical report, 15:33085 (R;US)
Ozone and acid-precipitation on western coniferous forests, 15:33134 (R;US)

FORMALDEHYDE
Development and validation of a test method for formaldehyde emissions. Report for February 1987-April 1989, 15:33081 (R;US)
Electronic excitation of formaldehyde by low-energy electrons: A theoretical study using the complex Kohn variational method, 15:33379 (J;US)
Health-hazard evaluation report HETA 89-007-1983, St. Thomas More Hospital, Canyon City, Colorado, 15:33236 (R;US)
Ultratrace determination of formaldehyde in potable water, 15:33256 (BA;US)
Unusual formaldehyde-induced hypersensitivity in two schoolgirls, 15:33257 (R;US)

FORMALIN
See FORMALDEHYDE

FORMALITH
See FORMALDEHYDE

FORMIC ALDEHYDE
See FORMALDEHYDE

FORMOL
See FORMALDEHYDE

FORTRAN
An oscillation detector used in the BPA power system disturbance monitor, 15:32431 (J;US)

FOSSIL FUEL RESERVES
See RESERVES

FOSSIL-FUEL POWER PLANTS
Long-term benthic monitoring studies in the freshwater portion of the Potomac River: 1983 to 1985, cumulative report. Volume 2. Appendices, 15:33144 (R;US)
Long-term benthic monitoring studies in the freshwater portion of the Potomac River: 1983 to 1985, cumulative report. Volume 1. Text, 15:33143 (R;US)
Nitrous oxide emissions from Danish power plants, 15:32096 (R;DK)
The Argonne Utility Simulation model: An analysis tool for evaluating energy and environmental strategies, 15:32097 (R;US)
The importance of clean coal technologies to reduce power plant emissions, 15:32312 (RA;US)

Utility retrofit demonstration using TRW slagging combustor technology: Environmental Assessment, 15:32309 (R;US)

FOUNDATIONS
Some post-test analyses of the 1/6th Sandia containment, 15:32396 (RA;US)

FOURIER TRANSFORM SPECTROMETERS
Influence of support gas composition on glow discharge properties, 15:33010 (BA;US)

FRACTALS
Polymers, fractals, and ceramic materials, 15:32671 (J;US)

FRACTURED FORMATIONS
See FRACTURED RESERVOIRS

FRACTURED RESERVOIRS
Design and evaluation of lost-circulation materials for severe environments, 15:32300 (J;US)

FRACTURING
3.5% cold leg break test without hydroaccumulator application: Computerized measurement analysis, 15:32375 (R;HU;In Hungarian)

FRAGMENTS (PARTICLES)
See PARTICLES

FRANCE
Public perception and acceptance of the siting of nuclear waste facilities in seven countries, 15:32218 (R;US)

FREE ELECTRON LASERS
Eigenmode analysis of optical guiding in free-electron lasers, 15:32904 (J;US)
Microwave generation for magnetic fusion energy applications, Task A: Progress report, September 15, 1989–September 14, 1990, 15:33732 (R;US)
Photo-injector, accelerator chain and wiggler development programs for a high peak power RF-Free electron laser, 15:32921 (R;FR)

FREE ENERGY
Calculation of free energy from the internal-energy distribution function, 15:33615 (R;US)

FREE ENERGY (HELMHOLTZ)
See FREE ENERGY

FREE RADICALS
See RADICALS

FREQUENCY MEASUREMENT
Structure and RF characteristics of the INS 25.5-MHz split coaxial RFQ, 15:32923 (R;JP)

FRESH WATER
Dechlorination of pentachlorophenol, 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid in anaerobic freshwater sediments, 15:33148 (R;US)

FRM DEVICES (THERMONUCLEAR)
See FIELD-REVERSED MIRROR REACTORS

FUEL BUNDLES
See FUEL ELEMENT CLUSTERS

FUEL CANS
Florestan-Material Test, 15:32374 (R;DE;In German)
Modeling of Zircaloy cladding degradation under repository conditions, 15:32239 (R;US)

FUEL CELLS
Monolithic solid oxide fuel-cell technology development. Phase 1A. Final report, February 1987-March 1989, 15:32477 (R;US)

FUEL COOLING INSTALLATIONS
See SPENT FUEL STORAGE

FUEL ELEMENT CLUSTERS
FIDAS: a three-fluid subchannel code for dryout prediction in rod bundles, 15:32869 (R;JP)

FUEL ELEMENTS
See also FUEL PINS
FUEL RODS
SPENT FUEL ELEMENTS
Effect of rib on burnout heat flux, 15:32339 (R;US)

FUEL INTEGRITY
Benchmarking of FEMAXI-IV code with fuel irradiation data in power reactors, 15:32320 (R;JP;In Japanese)

FUEL PENCILS
See FUEL PINS

FUEL PINS
Studies on vibration of fuel rods Pt. 1: Mechanical models of vibration of fuel rods in PWRs, 15:32340 (R;HU;In Hungarian)

FUEL REPROCESSING PLANTS
See also WACKERSDORF REPROCESSING PLANT
Application of near real time accountancy to nuclear material balance data, 15:32257 (R;DE)

FUEL ROD CONSOLIDATION
See FUEL RODS

FUEL RODS
Internal hydriding in irradiated defected Zircaloy fuel rods, 15:32572 (BA;US)

FUEL SHEATHS
See FUEL CANS

FUEL SLUGS
See FUEL RODS

FUEL SLURRIES
Heat engines program: Fiscal year 1990, Summary program plan, 15:32113 (R;US)
Industrial burners for combustion of high concentration water-coal slurries and respective combustion, 15:32116 (R;XE)
Reduction of ash sticking in direct coal-fired gas turbine engines, 15:32120 (BA;US)

FUEL SUSPENSIONS
See FUEL SLURRIES

FUELS
See also BOILER FUELS
FUEL SLURRIES
JET ENGINE FUELS
NUCLEAR FUELS
REFUSE DERIVED FUELS
SYNTHETIC FUELS
Shock tube ignition of isomers of octane, 15:32167 (R;US)

FUELS (NUCLEAR)
See NUCLEAR FUELS

FUMES
See AEROSOLS

FUNCTIONAL ANALYSIS
An error estimate for Tremolieres method for the discretization of parabolic variational inequalities, 15:33699 (R;XA)

FUNCTIONS
See also HAMILTONIAN FUNCTION
LAGRANGIAN FUNCTION
POLYNOMIALS
On comparable L^p-norms of subadditive functions on topological groups, 15:33678 (R;XA)

FUNDAMENTAL PARTICLES
See ELEMENTARY PARTICLES

FUSION (NUCLEAR)
See THERMONUCLEAR REACTIONS

FUSION ENERGY
See THERMONUCLEAR REACTORS

FUSION REACTIONS
See HEAVY ION FUSION REACTIONS

FUSION REACTORS
See THERMONUCLEAR REACTORS

G

G CODES
Obsidian hydration dating: Field, laboratory, and modeling results, 15:33279 (BA;US)

GADOLINIUM
Electron spectroscopic investigation of atomic 4d giant resonances for Ba, La and lanthanides, 15:33331 (R;DE;In German)

GADOLINIUM 146
Possible evidence for four-particle, four-hole excitations in ^{146}Gd, 15:33582 (J;US)

GADOLINIUM 148 TARGET
Possible evidence for four-particle, four-hole excitations in ^{146}Gd, 15:33582 (J;US)

GADOLINIUM ALLOYS
Preparation, fabrication and properties of a rare earth intermetallic compound - GdPd, 15:32644 (BA;US)

GADOLINIUM COMPOUNDS
See also GADOLINIUM OXIDES
GADOLINIUM SILICIDES
Radiation induced amorphization in $YBa_2Cu_3O_7$ and $GdBa_2Cu_3O_7$ superconductors, 15:32896 (BA;US)

GADOLINIUM OXIDES
Magnetism, specific heat, and pressure-dependent reistivity of the electron-doped compounds LnMCuO(Ln = Pr,Nd,Sm,Eu,Gd:M = Ce,Th), 15:32641 (BA;US)

GADOLINIUM SILICIDES
Valence photoelectron spectroscopy of Gd silicides, 15:32769 (J;US)

GALAXIES
See also MILKY WAY
A suggestion on the pair QSO triplets 1130+106 {B,A,C}, {x,y,z}, 15:33294 (R;BR)
Quantifying the FIR interaction enhancement in paired galaxies, 15:33292 (R;XA)
Shapes of star-gas waves in spiral galaxies, 15:33297 (R;US)
The disk-halo connection and the nature of the interstellar medium, 15:33298 (R;US)

GALERKIN-PETROV METHOD
Applications of mixed Petrov-Galerkin finite element methods to transient and steady state creep analysis, 15:33709 (R;BR)
Dual and primal mixed Petrov-Galerkin finite element methods in heat transfer problems, 15:33711 (R;BR)
Finite element analysis of nonlinear creeping flows, 15:33710 (R;BR)

GALLIUM
Abrupt interfaces with novel structural and electronic properties: Metal-cluster deposition and metal-semiconductor junctions, 15:32600 (J;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 10. Primary and secondary germanium and gallium, primary rare earth metals, secondary indium. Index. Final report, 15:33162 (R;US)
Gallium a unique anti-resorptive agent in bone: Preclinical studies on its mechanisms of action, 15:33212 (R;US)

GALLIUM ANTIMONIDES
Applications of strained layer superlattices, 15:32715 (R;US)
Band-gap narrowing in ordered and disordered semiconductor alloys, 15:32750 (J;US)
Molecular beam epitaxy of $AlAs_{0.16}Sb_{0.84}$ and $Al_{0.8}Ga_{0.2}As_{0.14}Sb_{0.86}$ on InAs substrates, 15:32758 (J;US)

GALLIUM ARSENIDE SOLAR CELLS
Amorphous GaAs thin layers, 15:32283 (R;FR;In French)

GALLIUM ARSENIDES
Abrupt interfaces with novel structural and electronic properties: Metal-cluster deposition and metal-semiconductor junctions, 15:32600 (J;US)
Absolute pressure dependence of the second ionization level of EL2 in GaAs, 15:32755 (J;US)
Adsorption and decomposition of trimethylarsenic on GaAs (100), 15:32722 (BA;US)
Application of x-ray scattering to the in situ study of organometallic vapor phase epitaxy, 15:32721 (BA;US)
Applications of strained layer superlattices, 15:32715 (R;US)
Band-gap narrowing in ordered and disordered semiconductor alloys, 15:32750 (J;US)
Defect reduction in MOCVD grown Si/GaAs, 15:32724 (BA;US)
Lattice-mismatched $In_{0.53}Ga_{0.47}As/In_{0.52}Al_{0.48}As$ modulation-doped field-effect transistors on GaAs: Molecular-beam epitaxial growth and device performance, 15:32772 (J;US)
Molecular beam epitaxy regrowth by use of ammonium sulfide chemical treatments, 15:32753 (J;US)
New surface atomic structures for III-V(110)-p(1×1)-Sb(1ML): Chemical bonding and electronic structure, 15:32808 (R;US)
Phonon temperature overshoot in GaAs excited by subpicosecond laser pulses, 15:33636 (J;US)
Pyrolytic and laser photolytic growth of crystalline and amorphous germanium films digermane (Ge_2H_6), 15:32739 (BA;US)
Surface photovoltage spectroscopy of real n-type GaAs(110) surfaces, 15:33619 (R;XA)
Temperature dependence of compositional disordering of GaAs-AlAs superlattices during MeV Kr irradiation, 15:32774 (J;US)
The growth of high quality CdTe on GaAs by molecular beam epitaxy, 15:32754 (J;US)
The photoluminescence and TEM studies of patterned GaAs films on Si substrate grown by molecular beam epitaxy, 15:32729 (BA;US)

GALLIUM PHOSPHIDES
Band-gap narrowing in ordered and disordered semiconductor alloys, 15:32750 (J;US)
Defect reduction in MOCVD grown Si/GaAs, 15:32724 (BA;US)
GaP/Si heteroepitaxial layers with reduced defect density, 15:32733 (BA;US)

GAMMA ASTRONOMY
Cosmology with 100-TeV γ-ray telescopes, 15:33317 (J;US)

GAMMA CAMERAS
Gabor zone plate apertures for imaging with the mercuric iodide gamma ray camera, 15:32973 (R;US)

GAMMA DOSIMETRY
PBF/BNCT [Power Burst Facility/Boron Neutron Capture Therapy] Program for Cancer Treatment: Monthly bulletin, Volume 4, No. 3, 15:33222 (R;US)

GAMMA RADIATION
An aerial radiological survey of the Evans Area, US Army Communications-Electronics Command, Fort Monmouth, New Jersey: Date of survey, November 1988, 15:33055 (R;US)
An aerial radiological survey of the United States Department of Energy's Rocky Flats Plant, Golden, Colorado: Date of survey, July 1989, 15:33057 (R;US)
Decontamination impacts on solidification and waste disposal, 15:32200 (R;US)

GAMMA REACTIONS
See PHOTONUCLEAR REACTIONS

GAMMA SPECTROSCOPY
Applications of gamma-ray spectrometry in the quantitative nondestructive assay of special nuclear materials, 15:32258 (R;US)
Detection limits for Gamma-Ray spectral analysis, 15:32969 (R;FR;In French)

GAS BURNERS
Development of a catalytic infrared cooking gas burner, 15:32178 (R;US)
Pulsating burners - controlling mechanisms and performance. Annual report, January 1-December 31, 1988, 15:32183 (R;US)

GAS COOLANTS
See GASES

GAS ENGINES
See INTERNAL COMBUSTION ENGINES

GAS HYDRATES
Ground movements associated with gas hydrate production in geologic media: Final report, 15:32172 (R;US)

GAS LASERS
See also CARBON DIOXIDE LASERS
METAL VAPOR LASERS
X-ray preionization technology for high pressure gas discharge lasers, 15:32890 (BA;US)

GAS METAL-ARC WELDING
Sensing of metal-transfer mode for process control of GMAW [gas metal arc welding], 15:32848 (R;US)

GAS TURBINE ENGINES
Reduction of ash sticking in direct coal-fired gas turbine engines, 15:32120 (BA;US)

GAS TURBINE POWER PLANTS
Environmental review of Southern Maryland Electric Cooperative's proposed combustion-turbine generating facility at Chalk Point, 15:32317 (R;US)

GASEOUS EFFLUENTS
See GASEOUS WASTES

GASEOUS WASTES
See also FLUE GAS

Continuous emission monitoring of hazardous waste incinerators using Fourier transform infrared spectroscopy, 15:33110 (BA;US)
Demonstration of noble gas collection using the cryogenic technique, 15:33060 (R;US)

GASES
See also AIR
COSMIC GASES
ELECTRON GAS
RARE GASES
VAPORS
VOLCANIC GASES
A perfluorocarbon tracer transport and dispersion experiment in the North Sea Ekofisk oil field: Revision, 15:33116 (R;US)
Soil gas surveying at low-level radioactive waste sites, 15:32215 (R;US)

GASOLINE
Enhanced bioremediation utilizing hydrogen peroxide as a supplemental source of oxygen: A laboratory and field study. Final report, August 1987-November 1989, 15:32157 (R;US)

GASOLINE ENGINES
See INTERNAL COMBUSTION ENGINES

GAUGE INVARIANCE
Dynamically generated fermionic masses, 15:33479 (BA;US)
External sources for topologically massive gauge fields, 15:33513 (J;US)
Gauge transformations for six dimensional superfields, 15:33474 (R;BR)
Non-linear σ-models and string theories, 15:33511 (BA;US)
Torsion-induced gauge superfield mass generation for gauge-invariant non-linear σ-models, 15:33473 (R;BR)

GAUGE TRANSFORMATIONS
See GAUGE INVARIANCE

GEKKO FACILITY
High intensity short pulse generation at ILE Osaka University, 15:32936 (RA;JP)

GENE MUTATIONS
Fidelity of DNA polymerases in DNA amplification, 15:33204 (J;US)

GENERAL RELATIVITY THEORY
See also RELATIVITY THEORY
Unexpected properties of the centrifugal force, 15:33694 (R;XA)

GENERATORS (AEROSOL)
See AEROSOL GENERATORS

GENERATORS (PULSE)
See PULSE GENERATORS

GENERATORS (STEAM)
See STEAM GENERATORS

GENETIC ENGINEERING
Methods to measure the influence of genetically engineered bacteria on ecological processes in soil, 15:32281 (R;US)
Monitoring for genetically engineered pseudomonas species in monterey county, 15:32282 (R;US)

GEOCHEMICAL SURVEYS
Identification of tectonic disturbed zones in 2 soil gas profiles from Northern Switzerland, 15:33276 (R;CH;In German)

GEOCHEMISTRY
Subsurface Science Program: Program overview and research abstracts, FY 1989–FY 1990, 15:33122 (R;US)

GEOLOGIC DEPOSITS
See also COAL DEPOSITS
NATURAL GAS DEPOSITS
URANIUM DEPOSITS
Geologic map of the surficial deposits of the Yucca Flat area, Nye County, Nevada, 15:33278 (R;US)
Paleotectonic significance of the quartzite of the Sauratown Mountains window, North Carolina, 15:33282 (J;US)

GEOLOGIC FAULTS
Subduction zone tectonic studies to develop concepts for the occurrence of sediment subduction (Phase 2): Volume 3: Final report, 15:32170 (R;US)

GEOLOGIC FORMATIONS
Design of a gun system for in-situ compressive strength measurements, 15:33037 (R;US)

GEOLOGIC FRACTURES
See also GEOLOGIC FAULTS
Acoustic and elastic diffraction tomography and its application to fracture detection, 15:33262 (R;US)
Radar investigations at the Saltsjoetunnel - predictions and validation, 15:32238 (R;SE)

GEOLOGIC MODELS
Design of a gun system for in-situ compressive strength measurements, 15:33037 (R;US)

GEOLOGIC SURVEYS
Critical heterogeneities in a barrier island deposit and their influence on various recovery processes, 15:32127 (J;US)

GEOLOGICAL SURVEYS
See GEOLOGIC SURVEYS

GEOLOGY
See also PETROLEUM GEOLOGY
Digital image integration technique of multiple geoscience information system and its application, 15:32191 (R;CN;In Chinese)

GEOMAGNETIC FIELD
Solar-Geophysical Data Number 544, December 1989. Part 1 (prompt reports). Data for November, October 1989, and late data, 15:33312 (R;US)
Solar-Geophysical Data Number 545, January 1990. Part 1 (prompt reports). Data for December, November 1989, and late data, 15:33313 (R;US)

GEOTHERMAL AREAS
See GEOTHERMAL FIELDS

GEOTHERMAL FIELDS
Seismic imaging for velocity and attenuation structure in geothermal fields, 15:32297 (R;US)
The Newcastle geothermal system, Iron County, Utah: Geology, hydrology, and conceptual model, Volume 1: Final report, 15:32295 (R;US)

GEOTHERMAL REGIONS
See GEOTHERMAL FIELDS

GEOTHERMAL SYSTEMS
Camborne geothermal energy project 2C-5. Final report Phase 2C: October 1986 - September 1988, 15:32296 (R;GB)

GEOTHERMAL WELLS
Design and evaluation of lost-circulation materials for severe environments, 15:32300 (J;US)

GERMAN FEDERAL REPUBLIC
See FEDERAL REPUBLIC OF GERMANY

GERMANES
See GERMANIUM HYDRIDES

GERMANIUM
Damage formation in semiconductors during MeV ion implantation, 15:32740 (BA;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 10. Primary and secondary germanium and gallium, primary rare earth metals, secondary indium. Index. Final report, 15:33162 (R;US)
Electrical and thermal properties of neutron-transmutation-doped Ge at 20 mK, 15:32595 (J;US)
Electronic properties of Si-Ge micro nipi structures, 15:32741 (BA;US)
Hydrogen ion beam smoothening of oxygen roughened η(001) surfaces, 15:32584 (BA;US)
Measurements of time delays for projectile-like fragments in the reaction ^{40}Ar+Ge at 44 MeV/nucleon, 15:33537 (J;US)
Metastability in SiGe/Si strained-layer structures, 15:32738 (BA;US)
Nucleation of amorphous germanium from supercooled melts, 15:32752 (J;US)
Pyrolytic and laser photolytic growth of crystalline and amorphous germanium films digermane (Ge_2H_6), 15:32739 (BA;US)
Structural and chemical imaging of superconductors and semiconductors by high-resolution STEM, 15:32719 (BA;US)

GERMANIUM 74 REACTIONS
Heat partition in the E/A=8.5 MeV ^{74}Ge+^{165}Ho reaction, 15:33550 (J;US)
Nucleon exchange properties of the E/A=8.5 MeV ^{74}Ge+^{165}Ho reaction, 15:33549 (J;US)

GERMANIUM ALLOYS
Au-Ge-Ni-Ti ohmic contacts on gallium arsenide, 15:32537 (R;US)
GERMANIUM HYDRIDES
Theoretical study of GeH_n, AsH_n, and SeH_n: Ionization energies, 15:33384 (J;US)
GERMANIUM SILICIDES
Moving species during ion mixing in Ge_xSi_{1-x}/metal systems, 15:32760 (J;US)
GERMANY (FEDERAL REPUBLIC)
See FEDERAL REPUBLIC OF GERMANY
GERMS (MICROORGANISMS)
See MICROORGANISMS
GIANT RESONANCE
Isoscalar giant resonances in a relativistic model, 15:33572 (R;FR)
GLASS
Correlation between optical absorption and refractive index of silica and silicate glasses implanted with copper, 15:32723 (BA;US)
Effect of environmental materials on R7T7 nuclear waste glass alteration. Clay effect, 15:32201 (R;FR;In French)
Linear free energy relationships in glass corrosion, 15:32727 (BA;US)
Modeling jet penetration in glass, 15:33033 (R;US)
Prediction of glass durability as a function of environmental conditions, 15:32810 (BA;US)
Radiation effects in silicate glasses: A review, 15:32728 (BA;US)
WIPP/SRL [Waste Isolation Pilot Plant/Savannah River Laboratory] in-situ tests: MIIT [Materials Interface Interactions Tests] program—Glass/metal interfaces of SRS waste glass, 15:32241 (R;US)
WIPP/SRL [Waste Isolation Pilot Plant/Savannah River Laboratory] in-situ tests: Compositional correlations of MIIT [Materials Interface Interactions Test] waste glasses, 15:32213 (R;US)
GLASS MELTERS
See CERAMIC MELTERS
GLAUBER'S SALT
See SODIUM SULFATES
GLOBULINS-GAMMA
Single-sperm typing: Determination of genetic distance between the $^{G}\gamma$-globulin and parathyroid hormone loci by using the polymerase chain reaction and allele-specific oligomers, 15:33208 (J;US)
GLUON-GLUON INTERACTIONS
Gluon fusion as a source for massive-quark polarization, 15:33470 (J;US)
GLYCOGEN
Ordered synthesis and mobilization of glycogen in the perfused heart, 15:33205 (J;US)
GLYCOPROTEINS
[Hydroxyproline-rich glycoproteins of the plant cell wall]: Progress report, June 1989–June 1990, 15:33193 (R;US)
GLYCYLGLYCINE
Measurement of free ammonia produced by X irradiation of glycylglycine in aqueous solution, 15:33231 (J;US)
GOBAR GAS
See METHANE
GOLD
Abrupt interfaces with novel structural and electronic properties: Metal-cluster deposition and metal-semiconductor junctions, 15:32600 (J;US)
Comment on "Charge exchange and metastability of small multiply charged gold clusters", 15:33365 (J;US)
Deuterium interactions with ion-implanted oxygen in Cu and Au, 15:33344 (BA;US)
Encoding of the Burgess metal electrical resistivity model into SESAME format and its adaptation to the metal nickel, 15:32548 (R;US)
High-resolution study of dielectronic capture by channeled Ti ions, 15:33635 (J;US)
In situ HVEM study of ion irradiation-induced grain growth in Au thin films, 15:32725 (BA;US)
X-ray diffraction analysis of Au/Ni multilayers, 15:32570 (BA;US)
GOLD 197 REACTIONS
Lattice calculation of muon-pair production with capture in relativistic heavy-ion collisions, 15:33593 (J;US)
GOLD 197 TARGET
Changes in target fragmentation mechanisms with increasing projectile energy in intermediate energy nuclear collisions, 15:33555 (J;US)
Fragment emission in the reaction $^{40}Ar+^{197}Au$ at E/A=30 and 220 MeV, 15:33552 (R;DE)
Lattice calculation of muon-pair production with capture in relativistic heavy-ion collisions, 15:33593 (J;US)
GOLD ALLOYS
Au-Ge-Ni-Ti ohmic contacts on gallium arsenide, 15:32537 (R;US)
Neutron scattering experiments on $YbXCu_4$ and $ErXCu_4$ (X=Au, Pd, and Ag), 15:32591 (J;US)
GOLD IONS
Experimental determination of a species-dependent effect in the transverse emittances of sputter-generated negative-ion beams, 15:33640 (J;US)
GRAND GULF-1 REACTOR
Parametric CONTAIN calculations of the containment response of the Grand Gulf plant due to reactor pressure vessel failure at high pressure, 15:32382 (RA;US)
GRAPHITE
Effect of high temperature neutron irradiation on physical properties of OGL-1 graphite block, 15:32703 (R;JP;In Japanese)
Health-hazard evaluation report HETA 87-075-1988, American Cyanamid, Wallingford, Connecticut, 15:33074 (R;US)
Melting and orientational epitaxy in argon and xenon monolayers on graphite, 15:32776 (J;US)
Nanometer-scale pulsed laser modification of the basal plane of graphite observed with STM [scanning tunneling microscopy], 15:32716 (R;US)
GRAPHITE MODERATOR
See GRAPHITE
GRATINGS
Measurements of Smith–Purcell radiation, 15:32997 (J;US)
GRAVITATION
Gravity and antimatter, 15:33713 (J;US)
GRAVITATIONAL FIELDS
BRS symmetry in stochastic quantization of the gravitational field, 15:33476 (R;JP)
GRAVITATIONAL INTERACTIONS
A new short range gravitational force in the leptonic world, 15:33712 (R;FR)
GRAVITATIONAL WAVES
Propagation of electromagnetic radiation in a random field of gravitational waves and space radio interferometry, 15:33673 (R;XA)
GREAT BRITAIN
See UNITED KINGDOM
GREENHOUSE EFFECT
A critical appraisal of model simulations, 15:33107 (R;US)
Climate Caucus report: Opportunities for bridging the gaps from effects to impacts, 15:33103 (R;US)
Potential responses of landscape boundaries to global environmental change, 15:33051 (R;US)
GREENHOUSES
Comparative performance analysis: Commercial cut-flower rose production, 15:33218 (R;US)
GROSS-NEVEU MODEL
See LAGRANGIAN FIELD THEORY
GROUND MOTION
Characterization of high damping bearings and their responses to earthquake motions, 15:32842 (R;US)
Ground movements associated with gas hydrate production in geologic media: Final report, 15:32172 (R;US)
GROUND SUBSIDENCE
Ground movements associated with gas hydrate production in geologic media: Final report, 15:32172 (R;US)
GROUND WATER
Acidification
Nature demands stricter limits, 15:32105 (R;NL)

Contamination
Comparison of hydrologic data from mined and unmined areas in the carbondale Group of Daviess, Pike, and Gibson Counties, Indana. Final report, 15:32100 (R;US)
Development of an expert-system embedding pattern-recognition techniques for pollution-source identification. Report for 30 September 1987-29 November 1989, 15:33171 (R;US)
Economic impact study of landfill regulations (R88-7). Final report, 15:33165 (R;US)
Fiscal Year 1988 program report: Maine Environmental Studies Center, 15:32154 (R;US)
Health assessment for Beachwood Borough and Berkeley Township National Priorities List (NPL) Site, Ocean County, New Jersey, Region 2. CERCLIS No. NJD980654123. Final report, 15:33142 (R;US)
Interlaboratory methods comparison for the total organic carbon analysis of aquifer materials, 15:33170 (R;US)
Modeling organic-contaminant sorption impacts on aquifer restoration, 15:33169 (R;US)
Oasis: Parameter estimation system for aquifer-restoration models. User's manual. Version 2.0. Report for October 1987-September 1989, 15:33149 (R;US)
Superfund Record of Decision (EPA Region 2): FAA (Federal Aviation Administration) Technical Center, Atlantic County, New Jersey (First remedial action), September 1989, 15:32156 (R;US)
Superfund Record of Decision (EPA Region 4): Ciba-Geigy (McIntosh Plant), AL. (First remedial action), September 1989, 15:33176 (R;US)
Superfund Record of Decision (EPA Region 5): Ionia City Landfill, Ionia, Michigan (First remedial action, September 1989), 15:33147 (R;US)
Superfund Record of Decision (EPA Region 6): Motco Superfund Site, La Marque, Texas (second remedial action), September 1989. Final report, 15:33146 (R;US)
Superfund Record of Decision (EPA Region 7): Arkansas City Dump Site, Arkansas City, Kansas (Second remedial action), September 1989. Final report, 15:32155 (R;US)
Superfund Record of Decision (EPA Region 9): Purity Oil Sales, CA. (First remedial action), September 1989, 15:32158 (R;US)

Decontamination
Enhanced bioremediation utilizing hydrogen peroxide as a supplemental source of oxygen: A laboratory and field study. Final report, August 1987-November 1989, 15:32157 (R;US)

Extraction
Evaluation of ground-water extraction remedies. Volume 1. Summary report, 15:33166 (R;US)

Flow Models
Geohydrology of the 218-W-5 Burial Ground, 200-West Area, Hanford Site, 15:32231 (R;US)
LLUVIA: A program for one-dimensional, steady-state flow through partially saturated porous media, 15:32235 (R;US)

Fluid Flow
Evaluations of the effects of the Columbia River on the unconfined aquifer beneath the 1301-N Liquid Waste Disposal Facility, 15:32232 (R;US)

Pumping
Estimating pumping time and ground-water withdrawals using energy-consumption data. Water-Resources Investigation, 15:32460 (R;US)

Purification
Method and apparatus for the in situ decontamination of underground water with the aid of solar energy, 15:33191 (P;US)

Radioecological Concentration
Nuclear regulation: NRC's decommissioning procedures and criteria need to be strengthened, 15:32349 (R;US)

Radionuclide Migration
Program for low-level radiactive waste disposal at the Savannah River Site, a U.S. nuclear materials production facility, 15:32248 (BA;US)
Subsurface Science Program: Program overview and research abstracts, FY 1989–FY 1990, 15:33122 (R;US)
Surveillance of Site A and Plot M report for 1989, 15:33137 (R;US)

GROUND-WATER RESERVES
See AQUIFERS
GROUPS (SPACE)
See SPACE GROUPS
GROWTH (CRYSTAL)
See CRYSTAL GROWTH
GROWTH (ECONOMIC)
See ECONOMIC GROWTH
GUNS
Design of a gun system for in-situ compressive strength measurements, 15:33037 (R;US)
GYROTRONS
See MICROWAVE AMPLIFIERS

H

H-1 HELIAC
A diagnostic for 2D density profiles in Heliac H-1, 15:33728 (RA;AU)
ICH system for Heliac H1 (Ion Cyclotron Heating.), 15:33726 (RA;AU)
Papers presented at seventh international workshop on stellarators, 15:33802 (R;AU)
Vacuum field optimization and the effects of field errors on the flux surfaces of the H-1 Heliac, 15:33803 (RA;AU)
HAAG-ARAKI FIELD THEORY
See ALGEBRAIC FIELD THEORY
HADRON-HADRON INTERACTIONS
Fractal measures in multiparticle production, 15:33461 (J;US)
Hadron-collider limits on new electroweak interactions from the heterotic string, 15:33454 (J;US)
HADRONS
See also BARYONS
MESONS
Hadron physics: Summary papers on hadron physics for the NSAC long range plan, 15:33434 (R;US)
HAFNIUM
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 9. Primary and secondary titanium, primary zirconium and hafnium. Final report, 15:33161 (R;US)
HAIR
Concentrations of metals in Norton Sound seawater samples and human hair samples, 1989, 15:33188 (R;US)
HALL GENERATORS
See MHD GENERATORS
HAMILTON OPERATORS
See HAMILTONIANS
HAMILTONIAN FUNCTION
On Dirac's conjecture for Hamiltonian systems with first and second class constraints, 15:33485 (R;XA)
HAMILTONIANS
Kinematic moment invariants for linear Hamiltonian systems, 15:33717 (J;US)
HANDBOOKS
See MANUALS
HANDLING (WASTES)
See WASTE MANAGEMENT
HANFORD RESERVATION
183-H solar evaporation basins closure/post-closure plan: Revision 2, 15:32209 (R;US)
Evapotranspiration studies for protective barriers: FY 1988 status report, 15:32227 (R;US)
Field Lysimeter Test Facility: Second year (FY 1989) test results, 15:32228 (R;US)
Geohydrology of the 218-W-5 Burial Ground, 200-West Area, Hanford Site, 15:32231 (R;US)
Hanford Environmental Dose Reconstruction Project: Monthly report, 15:33102 (R;US)
Hanford Site National Environmental Policy Act (NEPA) characterization: Revision 2, 15:33101 (R;US)
Hanford Waste Vitrification Plant Clean Air Act permit application, 15:32211 (R;US)

HARMONIC OSCILLATORS
Quantum chaos and dissipation: Lyapunov exponents, 15:33674 (R;XA)
HASTELLOY C-276
See HASTELLOYS
HASTELLOY C-4
See HASTELLOYS
HASTELLOYS
See also ALLOY-NI49CR22FE18MO9
Study of metal corrosion using ac impedance techniques in the STS launch environment, 15:32549 (RA;US)
HAVAR
Recommended Bethe–Bloch stopping power parameters for Kapton and Havar, 15:33598 (J;US)
HAWAII
Hawaii Natural Energy Institute: 1989 Annual report, 15:32452 (R;US)
HAZARDOUS MATERIALS
Chemical Analysis
SST [single-shell tank] sample characterization analysis of archive samples 102-C, 105-C, and 106-C, 15:32230 (R;US)
Combustion
Offgas system particulate cleaning test and evaluation for the Process Experimental Pilot Plant, 15:32216 (R;US)
Operations and research at the US EPA Incineration Research Facility: Annual report for FY89, 15:33089 (R;US)
Relationship between CO, POHC, and pic emissions from a simulated hazardous waste incinerator, 15:33086 (R;US)
Environmental Impacts
Stabilization/solidification of CERCLA and RCRA wastes: Physical tests, chemical testing procedures, technology screening, and field activities, 15:32445 (R;US)
Environmental Transport
Fiscal Year 1988 program report: Maine Environmental Studies Center, 15:32154 (R;US)
Minimization
Alternative solvents/technologies for paint stripping: Phase 1, 15:32505 (R;US)
Oxidation
Destruction of propellant components in supercritical water, 15:32806 (R;US)
Pollution Regulations
Resource Conservation and Recovery Act (RCRA): Hazardous wastes. August 1978-March 1990 (A Bibliography from the NTIS data base). Report for August 1978-March 1990, 15:32510 (R;US)
Remote Handling
Sensor-based automated docking of large payloads, 15:32857 (R;US)
Removal
The coast guard's cleanup of hazardous waste sites, 15:33126 (R;US)
Toxicity
Fiscal Year 1989 report: Initial performance evaluation of three bioassays modified for direct in-situ testing, 15:33244 (R;US)
Vitrification
Hanford Waste Vitrification Plant Clean Air Act permit application, 15:32211 (R;US)
Waste Disposal
Evaluation of ground-water extraction remedies. Volume 1. Summary report, 15:33166 (R;US)
Waste Management
Federal-facilities Hazardous-Waste Compliance Manual. Final report, 15:32447 (R;US)
Management of hazardous and environmentally sensitive materials. Final report, 15:32444 (R;US)
Remedial Action Assessment System (RAAS): Evaluation of selected feasibility studies of CERCLA [Comprehensive Environmental Response, Compensation, and Liability Act] hazardous waste sites, 15:32229 (R;US)
Waste Processing
Description of Risk Reduction Engineering Laboratory: Test and evaluation facilities, 15:33163 (R;US)
Forum on innovative hazardous-waste-treatment technologies: Domestic and international. Held in Atlanta, Georgia on Hune 19-21, 1989. Technical papers, 15:33132 (R;US)
Treatment and destruction of hazardous chemical wastes, 15:33106 (R;US)
HD 6077
See NICKEL BASE ALLOYS
HEALTH HAZARDS
Effectiveness of water spray mitigation systems for accidental releases of hydrogen fluoride: Volume 6, Appendix H, Selected still photographs, 15:33056 (R;US)
HEALTH PHYSICS
See RADIATION PROTECTION
HEART
Ordered synthesis and mobilization of glycogen in the perfused heart, 15:33205 (J;US)
HEAT ENGINES
See also INTERNAL COMBUSTION ENGINES
Heat engines program: Fiscal year 1990, Summary program plan, 15:32113 (R;US)
HEAT EXCHANGERS
Heat exchangers: Biofouling. April 1974-January 1990 (A Bibliography from the COMPENDEX data base). Report for April 1974-January 1990, 15:32867 (R;US)
HEAT FLUX
Effect of rib on burnout heat flux, 15:32339 (R;US)
HEAT PUMPS
Initial parametric results using CYCLEZ—An LMTD-specified, Lorenz-Meutzner cycle refrigerator-freezer model, 15:32503 (R;US)
Magnetic heat pumps, 15:32499 (R;US)
Practical ice thermal storage applications, 15:32490 (B;US)
HEAT SOURCES
Titanium-boron mixtures as variable heat sources, 15:32437 (R;US)
HEAT STORAGE DEVICES
See THERMAL ENERGY STORAGE EQUIPMENT
HEAT STORAGE SYSTEMS
See THERMAL ENERGY STORAGE EQUIPMENT
HEAT TRANSFER
A comparison of analytical approaches for wellbore heat transmission in layered formations, 15:33261 (R;US)
RELAP5 thermal-hydraulic analysis of the SNUPPS [Standardized Nuclear Unit Power Plant System] pressurized water reactor, 15:32422 (R;US)
The RELAP5/MOD3 computer code, 15:32363 (R;US)
Verification and benchmarking of ABAQUS and PATRAN for heat transfer applications, 15:32863 (R;US)
HEAT TRANSMISSION
See HEAT TRANSFER
HEAVY ION FUSION REACTIONS
Multiple arc ion sources for heavy ion fusion, 15:33833 (J;US)
HEAVY ION REACTIONS
See also ARGON 40 REACTIONS
CALCIUM 40 REACTIONS
CARBON 13 REACTIONS
GERMANIUM 74 REACTIONS
GOLD 197 REACTIONS
KRYPTON 86 REACTIONS
LITHIUM 6 REACTIONS
OXYGEN 17 REACTIONS
SAMARIUM 154 REACTIONS
SILICON 28 REACTIONS
SULFUR 32 REACTIONS
THORIUM 232 REACTIONS
URANIUM 238 REACTIONS
Entropy content from strange particle ratios in the E802 experiment, 15:33445 (R;HU)
Entropy production in the relativistic heavy ion collisions, 15:33446 (R;HU)
Nonperturbative QED and loop bremsstrahlung of neutral lepton pairs in heavy-ion collisions, 15:33525 (J;US)
Nuclear dynamics with the finite range Gogny force, 15:33577 (R;FR)

SAM revisited: absorptive uniform semiclassical approximation and application to heavy-ion elastic scattering, 15:33570 (R;BR)
Theoretical and experimental aspects of the multiple fragmentation reactions in the nucleus-nucleus collisions at intermediate energies, 15:33567 (R;FR;In French)
Track models and radiation chemical yields, 15:32832 (BA;US)

HEAVY IONS
Operating experience with the Argonne PIIECR ion source system, 15:32928 (J;US)
Relativistic heavy ions from the BNL [Brookhaven National Laboratory] booster medical research and technological applications, 15:32907 (R;US)

HEAVY OILS
See PETROLEUM
VISCOSITY

HEISENBERG MODEL
2+1 topological term, anyons and their possible application in high T_c superconductivity, 15:33496 (R;XA)

HELIUM
Analyses of natural gases, 1917-1989. Data file, 15:32182 (R;US)
Enhanced radiative Auger emission from lithiumlike $_{16}S^{13+}$, 15:33381 (J;US)
Experimental simulation of a gaseous plasma collector, 15:33834 (J;US)
Ion implantation and ion beam analysis of lithium niobate, 15:32657 (BA;US)
Nuclear-charge screening in electron capture, 15:33375 (J;US)
Two-body fragmentation channels of three-body systems, 15:33367 (J;US)
Variational methods for high-order multiphoton processes, 15:33360 (J;US)

HELIUM 3
See also HELIUM 3 A
HELIUM 3 B
Transportation and operations aspects of space energy systems, 15:32263 (RA;US)

HELIUM 3 A
New mode of growth of ^{3}He-*B* in hypercooled ^{3}He-*A*: Evidence of a spin supercurrent, 15:33394 (J;US)

HELIUM 3 B
New mode of growth of ^{3}He-*B* in hypercooled ^{3}He-*A*: Evidence of a spin supercurrent, 15:33394 (J;US)

HELIUM 4
See also HELIUM II
Integrodifferential equation approach. Pt. 2. Triton and α-particle wave functions. Graphical plots, 15:33563 (R;DE)

HELIUM 4 REACTIONS
See ALPHA REACTIONS

HELIUM 4 TARGET
Quasielastic electron scattering and Coulomb sum rule in ^{4}He, 15:33417 (J;US)

HELIUM II
Investigations on cooling by forced flow of helium II driven by fountain effect pumps, 15:32865 (R;DE;In German)

HELIUM IONS
Muon reactivation in muon-catalyzed *d-t* fusion from accurate *p*-He* stripping and excitation cross sections, 15:33368 (J;US)

HELMHOLTZ FREE ENERGY
See FREE ENERGY

HERA STORAGE RING
Behaviour of the ZEUS uranium-scintillator calorimeter for low-energetic particles with energies of 0.2 - 10.0 GeV, 15:32972 (R;DE;In German)
Development of a precise hadron calorimeter, 15:32971 (R;DE;In German)

HERBICIDES
Comparison of serum levels of 2,3,7,8-tetrachlorodibenzo-p-dioxin with indirect estimates of Agent Orange exposure among Vietnam veterans. Final report, 15:33235 (R;US)
Toxicity bioassays: Water pollution effects on aquatic animals and plants. June 1986-February 1990 (A bibliography from the Selected Water Resources Abstracts data base). Report for June 1986-February 1990, 15:33183 (R;US)

HEREDITARY DISEASES
The Huntington disease locus is most likely within 325 kilobases of the chromosome 4p telomere, 15:33210 (J;US)

HETEROCHROMOSOMES
The Huntington disease locus is most likely within 325 kilobases of the chromosome 4p telomere, 15:33210 (J;US)

HETEROGENEOUS REACTOR CORES
Solution of the multigroup transport equations for fuel element assemblies according to the first collision procedure, 15:32331 (R;DE;In German)

HEXENES
Calculation of vibrational-energy-transfer quantities at high temperatures. Energy and temperature dependence, 15:32839 (J;US)

HIGGS BOSONS
Search for a light Higgs boson at the Fermilab Tevatron proton-antiproton collider, 15:33424 (J;US)

HIGGS MODEL
Dynamically generated fermionic masses, 15:33479 (BA;US)
Electroweak BAU generation on the lattice: Real time vs. Euclidean approach, 15:33507 (R;DK)

HIGH ENERGY PHYSICS
Report of the Expert Committee 'Intermediate-Energy Physics' 1986-1988/89, 15:33400 (R;DE;In German)
Supplement to the report of the Expert Committee 'Intermediate-Energy Physics' 1986-1988/89, 15:33401 (R;DE;In German)

HIGH ENERGY RADIOTHERAPY
See RADIOTHERAPY

HIGH EXPLOSIVES
See CHEMICAL EXPLOSIVES

HIGH PRESSURE COOLANT INJECTION
Preliminary observations of upcoming Phase II gate valve flow interruption tests, 15:32408 (RA;US)

HIGH TEMPERATURE GAS COOLED AND GRAPHITE MODERATED REACTORS
See HTGR TYPE REACTORS

HIGH-BETA PLASMA
A survey of theoretical research on the EXTRAP concept, 15:33786 (R;SE)
Influence of an energetic ion population on tokamak plasma stability, 15:33793 (J;US)

HIGH-LEVEL RADIOACTIVE WASTES
Hanford Waste Vitrification Plant Clean Air Act permit application, 15:32211 (R;US)
Initial operation of liquid waste treatment at the West Valley demonstration project, 15:32247 (BA;US)
LLUVIA: A program for one-dimensional, steady-state flow through partially saturated porous media, 15:32235 (R;US)
Monitored Retrievable Storage facility site screening and evaluation report: Volume 3, 15:32208 (R;US)
Monitored retrievable storage facility site screening and evaluation report: Volume 2, 15:32207 (R;US)
Monitored retrievable storage facility site screening and evaluation report: Volume 1, 15:32206 (R;US)
Proceedings of the US Department of Energy Office of Environmental Restoration and Waste Management waste reduction workshop 4, 15:32204 (R;US)
WIPP/SRL [Waste Isolation Pilot Plant/Savannah River Laboratory] in-situ tests: Compositional correlations of MIIT [Materials Interface Interactions Test] waste glasses, 15:32213 (R;US)
Water levels in periodically measured wells in the Yucca Mountain Area, Nevada, 1988, 15:32240 (R;US)
West Valley Demonstration Project annual report to Congress, 15:32243 (R;US)

HIGH-TC SUPERCONDUCTORS
In-situ growth of superconducting films of Bi-Sr-Ca-Cu-O using magnetron sputtering, 15:32604 (R;US)
NIST (National Institute of Standards and Technology) research reports, January 1990. Special pub, 15:33631 (R;US)
Practical superconductor development for electrical power applications: Annual report for FY 1989, 15:32878 (R;US)
Superconducting thin films of YBaCu oxides prepared by MOCVD, 15:32607 (R;US)

HIGHWAYS
See ROADS
HOLMIUM 165 TARGET
Heat partition in the *E/A*=8.5 MeV $^{74}Ge+^{165}Ho$ reaction, 15:33550 (J;US)
Nucleon exchange properties of the *E/A*=8.5 MeV $^{74}Ge+^{165}Ho$ reaction, 15:33549 (J;US)
HOLMIUM COMPOUNDS
Local oxygen configurations relative to $F_e$probe ions in $HoBa_2{}^{Cu}{}_{0.95}{}^{Fe}{}_{0.053}{}^{O}{}_{7-x}$, 15:32663 (BA;US)
HOSPITALS
Health-hazard evaluation report HETA 89-007-1983, St. Thomas More Hospital, Canyon City, Colorado, 15:33236 (R;US)
HOT GAS CLEANUP
High-sulfur coal research at the SIUC [Southern Illinois University at Carbondale] Coal Technology Laboratory: Quarterly progress report, January 1–March 31, 1990, 15:32041 (R;US)
HOUSES
Case study of the regional manufacturers' participation in the manufactured housing RCDP [Residential Construction Demonstration Project], 15:32482 (R;US)
Passive use of solar energy in the public housing of Capelle aan den IJssel, Netherlands: Evaluation and final report, 15:32291 (R;NL;In Dutch)
Radon-222, ^{222}Rn progeny, and ^{220}Rn progeny levels in 70 houses, 15:33111 (J;US)
HPCI
See HIGH PRESSURE COOLANT INJECTION
HTGR TYPE REACTORS
See also HTTR REACTOR
SONATINA-2H: a computer program for seismic analysis of the two-dimensional horizontal slice HTGR core, 15:32324 (R;JP)
HTTR REACTOR
Evaluation of reactivity coefficients for High Temperature Engineering Test Reactor (HTTR), 15:32352 (R;JP;In Japanese)
HTTR plant dynamic simulation using a hybrid computer, 15:32344 (R;JP;In Japanese)
The conceptual design of High Temperature Engineering Test Reactor upgraded through utilizing Pebble-in-Block fuel (UHTTR), 15:32323 (R;JP;In Japanese)
HUGENHOLTZ-PINES THEORY
See HYDROGEN
HUMAN CELLS
See ANIMAL CELLS
HUMAN POPULATIONS
See also A-BOMB SURVIVORS
An estimation of contribution to the population dose in Japan, 15:33601 (RA;JP;In Japanese)
Hanford Environmental Dose Reconstruction Project: Monthly report, 15:33102 (R;US)
Performance experience with radon mitigation systems, 15:32480 (R;US)
[Radiological protection of the public from intakes of radionuclides]: Foreign trip report, April 21, 1990–April 27, 1990, 15:33225 (R;US)
HUMANS
See HUMAN POPULATIONS
HUMIC ACIDS
Coal flotation and flocculation in the presence of humic acids, 15:32037 (RA;US)
HUMIDITY
Method of fabricating an oxide-aluminum humidity sensor, 15:33002 (R;US)
HYDRAULICS
RELAP5 thermal-hydraulic analysis of the SNUPPS [Standardized Nuclear Unit Power Plant System] pressurized water reactor, 15:32422 (R;US)
The RELAP5/MOD3 computer code, 15:32363 (R;US)
HYDRAZINE
Proton affinities and pK_a values of tetraalkylhydrazines, 15:32823 (J;US)
HYDROCARBONS
See also ALKANES
ALKENES
BENZENE
BIPHENYL
DURENE
POLYCYCLIC AROMATIC HYDROCARBONS
PYRENE
TOLUENE
XYLENES
Southern California Air Quality Study (SCAQS) description of measurement activities. Final report, 15:33093 (R;US)
HYDROCHLORIC ACID
Results of emissions and ash testing in full-scale co-combustion tests of binder-enhanced dRDF pellets and high-sulfur coal, 15:32513 (R;US)
Study of metal corrosion using ac impedance techniques in the STS launch environment, 15:32549 (RA;US)
HYDROCRACKING
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 23, July 1–September 30, 1988, 15:32063 (R;US)
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 25, October 1–December 31, 1988, 15:32064 (R;US)
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 29, January 1–March 31, 1989, 15:32065 (R;US)
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 17, April 1–June 30, 1988, 15:32062 (R;US)
HYDRODYNAMIC MODEL
Covariant smoothed particle hydrodynamics on a curved background, 15:33715 (J;US)
HYDROELECTRIC POWER
Energetic up-grading of wells in arterian basins, 15:32275 (R;FR;In French)
HYDROELECTRIC POWER PLANTS
Cumulative impact assessment: A case study, 15:32277 (R;US)
HYDROELECTRICITY
See HYDROELECTRIC POWER
HYDROFLUORIC ACID
Analysis of vapor barrier experiments to evaluate their effectiveness as a means to mitigate HF concentrations, 15:32143 (R;US)
Chemisorption of HF on silicon surfaces, 15:32720 (BA;US)
Effectiveness of water spray mitigation systems for accidental releases of hydrogen fluoride: Volume 6, Appendix H, Selected still photographs, 15:33056 (R;US)
Industry Cooperative Hydrogen Fluoride Mitigation & Ambient Impact Assessment Program: Summary report, 15:32145 (R;US)
Literature review of work related to impact of barriers on flammable cloud explosion overpressure: Vapor Barrier Assessment Program, Phase 2, Task 1, 15:32144 (R;US)
Numerical simulation of hypothetical gas explosions in a process unit: Effect of vapor barriers on explosion pressure, 15:32146 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 3, Appendices A–G, 15:32139 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A review of previous related work: Volume 2, Tables and figures for the detailed report, and Appendices A and B, 15:32142 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 4, Appendix H, Concentration contours in the Y-Z plane, 15:32140 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A review of previous related work: Volume 1, Detailed report, 15:32141 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 2, Figures and tables for the detailed report, 15:32138 (R;US)

Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 1, Detailed report, 15:32137 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air hydrogen fluoride vapor clouds: Summary report, 15:32136 (R;US)

HYDROGEN
Atom-Molecule Collisions
Production of N_2^+ first negative emission by impact of 1-MeV H^0, H^+, and H^- on N_2, 15:33378 (J;US)
Beryl
Decay kinetics study of atomic hydrogen in a-Si:(H,O,N) and natural beryl, 15:33335 (R;BR)
Bremsstrahlung
Bremsstrahlung induced by 50-MeV H^0 bombardment, 15:33639 (J;US)
Dissociation
Two-body fragmentation channels of three-body systems, 15:33367 (J;US)
Emission Spectra
Production of N_2^+ first negative emission by impact of 1-MeV H^0, H^+, and H^- on N_2, 15:33378 (J;US)
Energy Levels
Comments on relativistic correlation, 15:33346 (J;US)
Excited States
Formation of excited hydrogen states in stimulated desorption from an alkali-promoted surface, 15:33637 (J;US)
Ignition
Containment loading by deliberate ignition of flammable gas mixtures, 15:32381 (RA;US)
Development of a hydrogen mitigation strategy for degraded core accidents in a BWR/6 - Mark III power plant, 15:32385 (RA;US)
Ion Sources
H^0 temperature and density measurements in a Penning surface-plasma H^- ion source. I., 15:33792 (J;US)
Ion-Molecule Collisions
Angular distribution of Auger electrons and photons in resonant transfer and excitation in collisions of ions with light targets, 15:33364 (J;US)
Charge-transfer reactions of ground-state $C^+(^2P)$ and metastable-state $C^+(^4P)$ ions with H_2 molecules, 15:33371 (J;US)
Multi-Photon Processes
Strong-field laser ionization of alkali atoms using two-dimensional cylindrical and three-dimensional Cartesian time-dependent Hartree–Fock theory, 15:33358 (J;US)
Muonic Atoms
Two-body fragmentation channels of three-body systems, 15:33367 (J;US)
Nonlinear Optics
Indices governing optical self-focusing and self-induced changes in the state of polarization in N_2, O_2, H_2, and Ar gases, 15:32765 (J;US)
Positron-Atom Collisions
Positron–hydrogen-atom *S*-wave coupled-channel scattering at low energies, 15:33369 (J;US)
Proton Reactions
A dependence of highly inelastic *p*-nucleus collisions, 15:33418 (J;US)
Reaction Kinetics
Decay kinetics study of atomic hydrogen in a-Si:(H,O,N) and natural beryl, 15:33335 (R;BR)
Silicon
Decay kinetics study of atomic hydrogen in a-Si:(H,O,N) and natural beryl, 15:33335 (R;BR)
Solubility
Hydrogen dissolution in and release from nonmetals. II. Crystalline silicon, 15:32771 (J;US)
Stark Effect
Strong-field Stark effect: Perturbation theory and 1/n-expansion, 15:33333 (R;XA)
Thermodynamic Properties
The importance of thermodynamics to the modeling of nitrogen combustion chemistry, 15:32838 (J;US)
Waste Disposal
Safe venting of hydrogen, 15:32265 (R;US)
HYDROGEN 1 TARGET
Crossing-consistent analysis of kaon photoproduction and radiative capture, 15:33594 (J;US)
HYDROGEN 2
See DEUTERIUM
HYDROGEN 3
See TRITIUM
HYDROGEN CHLORIDES
See HYDROCHLORIC ACID
HYDROGEN FLUORIDES
See HYDROFLUORIC ACID
HYDROGEN HYDROXIDES
See WATER
HYDROGEN IONS
See also HYDROGEN IONS 1 MINUS
HYDROGEN IONS 1 PLUS
High-intensity plasma-sputter heavy negative-ion source (invited), 15:32957 (J;US)
Testing of a H_2^+-enriched ion source for deuterium simulation, 15:33349 (J;US)
HYDROGEN IONS 1 MINUS
Electron-suppression experiments in a small multicusp H^- source, 15:33366 (J;US)
Production of N_2^+ first negative emission by impact of 1-MeV H^0, H^+, and H^- on N_2, 15:33378 (J;US)
HYDROGEN IONS 1 PLUS
Muon reactivation in muon-catalyzed *d-t* fusion from accurate *p*-He^+ stripping and excitation cross sections, 15:33368 (J;US)
Nuclear-charge screening in electron capture, 15:33375 (J;US)
Production of N_2^+ first negative emission by impact of 1-MeV H^0, H^+, and H^- on N_2, 15:33378 (J;US)
HYDROGEN PEROXIDE
Enhanced bioremediation utilizing hydrogen peroxide as a supplemental source of oxygen: A laboratory and field study. Final report, August 1987-November 1989, 15:32157 (R;US)
Southern California Air Quality Study (SCAQS) description of measurement activities. Final report, 15:33093 (R;US)
HYDROGEN SELENIDES
See SELENIUM HYDRIDES
HYDROGEN SULFATES
See SULFURIC ACID
HYDROGENASE
See HYDROGENASES
HYDROGENASES
Hydrogen/sulfur metabolism in the hyperthermophilic archaebacterium Pyrodictium brockii: Progress report, March 1, 1989–February 28, 1990, 15:33211 (R;US)
HYDROGENATION
Coal liquefaction and hydrogenation: Processes and equipment. September 1971-November 1989 (A Bibliography from the US Patent data base). Report for September 1971-November 1989, 15:32074 (R;US)
HYDROLASES
DpnA, a methylase for single-strand DNA in the Dpn II restriction system, and its biological function, 15:33203 (J;US)
Preparative purification of Trichoderma reesei native and "core" Cellobiohydrolase I by electrophoresis and chromatofocussing, 15:33192 (R;US)
HYDROLOGY
Hydrologic modelling of the migration site at the Grimsel test site - the steady state, 15:33275 (R;CH)
Subsurface Science Program: Program overview and research abstracts, FY 1989–FY 1990, 15:33122 (R;US)
HYDROXYBENZENE
See PHENOL
HYDROXYTOLUENES
See CRESOLS
HYDROXYXYLENES
See XYLENOLS
HYPERCUBE COMPUTERS
Using the multistage cube network topology in parallel supercomputers, 15:33856 (J;US)

HYPERFRAGMENTS
See HYPERNUCLEI
HYPERNUCLEI
A consistent treatment of medium effects on hypernuclear pi-mesonic decay, 15:33337 (R;JP)
Search for radiative transitions in the hypernucleus $_{\Lambda}{}^{10}$B, 15:33533 (J;US)
Super-hypernuclei in the quark-shell model, 3, 15:33571 (R;JP)
The relative probability for the recoilless Λ-production in nuclei in the plane wave impulse approximation, 15:33568 (R;XA)
HYPERSONIC FLOW
Liquid crystal coatings for surface shear stress visualization in hypersonic flows, 15:32709 (R;US)
HYPOXANTHINE PHOSPHORIBOSYLTRANSFERASE
Fidelity of DNA polymerases in DNA amplification, 15:33204 (J;US)
HYPOXANTHINE QUANINE PHOSPHORIBOSYLTRANSFERASE
See HYPOXANTHINE PHOSPHORIBOSYLTRANSFERASE

I

IAEA
General report of the Insurance Study Committee, 15:32367 (R;IT)
ICE CONDENSERS
Ice melting progress in a nonuniformly loaded ice condenser facility, 15:32383 (RA;US)
ICF DEVICES
Investigation of ion implosion on the thermonuclear facility SOWA-400, 15:33817 (RA;CS;In Russian)
ICR HEATING
ICH system for Heliac H1 (Ion Cyclotron Heating.), 15:33726 (RA;AU)
JET ICRH antenna for pumped-divertor geometry, 15:33774 (RA;GB)
Technical progress report for ICRF [Ion Cyclotron Range of Frequencies] edge modeling, 15:33734 (R;US)
IDAHO ADVANCED TEST REACTOR
See ATR REACTOR
IDAHO NATIONAL ENGINEERING LABORATORY
Buried waste program at the Idaho National Engineering Laboratory, 15:32249 (BA;US)
Management information systems for environmental compliance activities, 15:32205 (R;US)
Reference site selection report for the advanced liquid metal reactor at the Idabo National Engineering Laboratory, 15:32347 (R;US)
Summary of the 1987 soil sampling effort at the Idaho National Engineering Laboratory Test Reactor Area Paint Shop Ditch, 15:33125 (R;US)
ILLINOIS
Determination of heavy metals on the Rock River through the analysis of sediments, 15:33145 (R;US)
Surveillance of Site A and Plot M report for 1989, 15:33137 (R;US)
ILLITE
Transmission electron microscopy study of illite/smectite mixed layers, 15:33129 (R;CH)
ILLUMINATION SYSTEMS
See LIGHTING SYSTEMS
IMPACT SHOCK
A comparison of CTH predictions with experimental armor/anti-armor data for long rod penetrators in two and three dimensions, 15:32873 (R;US)
IMPORT TAXES
See TARIFFS
IMPULSE
See PULSES
IN-BEAM SPECTROSCOPY
4π Si ball, 15:32976 (RA;JP;In Japanese)
INCINERATORS
Operations and research at the US EPA Incineration Research Facility: Annual report for FY89, 15:33089 (R;US)
Treatment and destruction of hazardous chemical wastes, 15:33106 (R;US)
INCONEL 600
Study of metal corrosion using ac impedance techniques in the STS launch environment, 15:32549 (RA;US)
INCONEL 625
Study of metal corrosion using ac impedance techniques in the STS launch environment, 15:32549 (RA;US)
INCONEL ALLOYS
Study of metal corrosion using ac impedance techniques in the STS launch environment, 15:32549 (RA;US)
INDEXES
Indexes to Nuclear Regulatory Commission issuances, July–December 1989: Volume 30, Index 2, 15:32328 (R;US)
INDIANA
Comparison of hydrologic data from mined and unmined areas in the carbondale Group of Daviess, Pike, and Gibson Counties, Indana. Final report, 15:32100 (R;US)
INDIANS (AMERICAN)
See AMERICAN INDIANS
INDIUM
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 10. Primary and secondary germanium and gallium, primary rare earth metals, secondary indium. Index. Final report, 15:33162 (R;US)
INDIUM ARSENIDES
Applications of strained layer superlattices, 15:32715 (R;US)
Band-gap narrowing in ordered and disordered semiconductor alloys, 15:32750 (J;US)
Defect reduction in MOCVD grown Si/GaAs, 15:32724 (BA;US)
Lattice-mismatched $In_{0.53}Ga_{0.47}As/In_{0.52}Al_{0.48}As$ modulation-doped field-effect transistors on GaAs: Molecular-beam epitaxial growth and device performance, 15:32772 (J;US)
INDIUM COMPOUNDS
See also INDIUM ARSENIDES
INDIUM OXIDES
INDIUM PHOSPHIDES
Chlorine reactive-ion-beam etching of InSb and $InAs_{0.15}Sb_{0.85}$/InSb strained-layer-superlattices, 15:32713 (R;US)
INDIUM OXIDES
Photoluminescence spectroscopy of thin indium-tin-oxide contracts on mercuric iodide substrates, 15:32632 (BA;US)
INDIUM PHOSPHIDES
Band-gap narrowing in ordered and disordered semiconductor alloys, 15:32750 (J;US)
INDOOR AIR POLLUTION
Performance experience with radon mitigation systems, 15:32480 (R;US)
INDUSTRIAL ACCIDENTS
Analysis of vapor barrier experiments to evaluate their effectiveness as a means to mitigate HF concentrations, 15:32143 (R;US)
Industry Cooperative Hydrogen Fluoride Mitigation & Ambient Impact Assessment Program: Summary report, 15:32145 (R;US)
Literature review of work related to impact of barriers on flammable cloud explosion overpressure: Vapor Barrier Assessment Program, Phase 2, Task 1, 15:32144 (R;US)
Major chemical accidents: Are we prepared?, 15:32443 (R;CA)
Numerical simulation of hypothetical gas explosions in a process unit: Effect of vapor barriers on explosion pressure, 15:32146 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 4, Appendix H, Concentration contours in the Y-Z plane, 15:32140 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 3, Appendices A–G, 15:32139 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 1, Detailed report, 15:32137 (R;US)

Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A review of previous related work: Volume 2, Tables and figures for the detailed report, and Appendices A and B, 15:32142 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A review of previous related work: Volume 1, Detailed report, 15:32141 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 2, Figures and tables for the detailed report, 15:32138 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air hydrogen fluoride vapor clouds: Summary report, 15:32136 (R;US)

INDUSTRIAL PLANTS
See also COAL GASIFICATION PLANTS
PETROLEUM REFINERIES
WASTE PROCESSING PLANTS
Air pollution: EPA's ambient air policy results in additional pollution, 15:33141 (R;US)
Analysis of vapor barrier experiments to evaluate their effectiveness as a means to mitigate HF concentrations, 15:32143 (R;US)
Industry Cooperative Hydrogen Fluoride Mitigation & Ambient Impact Assessment Program: Summary report, 15:32145 (R;US)
Literature review of work related to impact of barriers on flammable cloud explosion overpressure: Vapor Barrier Assessment Program, Phase 2, Task 1, 15:32144 (R;US)
Numerical simulation of hypothetical gas explosions in a process unit: Effect of vapor barriers on explosion pressure, 15:32146 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 4, Appendix H, Concentration contours in the Y-Z plane, 15:32140 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 1, Detailed report, 15:32137 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 2, Figures and tables for the detailed report, 15:32138 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A review of previous related work: Volume 1, Detailed report, 15:32141 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A review of previous related work: Volume 2, Tables and figures for the detailed report, and Appendices A and B, 15:32142 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air HF vapor clouds—A wind tunnel modeling evaluation: Volume 3, Appendices A–G, 15:32139 (R;US)
Vapor Barrier Assessment Program for delaying and diluting heavier-than-air hydrogen fluoride vapor clouds: Summary report, 15:32136 (R;US)

INDUSTRIAL SECTOR
See INDUSTRY

INDUSTRIAL WASTES
Report on the 1988 industrial direct discharges in Ontario, 15:33066 (R;CA)
Waste Management: Final technical report, April 1, 1987–March 31, 1988 including Quarterly technical progress report, January–March 1988, 15:32090 (R;US)
Waste minimization in historical perspective, 15:32512 (BA;US)

INDUSTRY
See also AGRICULTURE
CHEMICAL INDUSTRY
METAL INDUSTRY
NATURAL GAS INDUSTRY
NUCLEAR INDUSTRY
PETROLEUM INDUSTRY
Physical modeling of bubble phenomena, electrolyte flow and mass transfer in simulated advanced Hall cells: Final report, 15:32504 (R;US)
Waste minimization in historical perspective, 15:32512 (BA;US)

INERTIAL CONFINEMENT
A review of self generated B-field in ICF corona, 15:33816 (R;XA)
Electrical power from Inertial Confinement Fusion: Issues and prospects: Revision 1, 15:33823 (R;US)
Temporal behaviour of self generated magnetic field and its influence on inhibition of thermal flux in ICF plasma, 15:33815 (R;XA)

INERTIAL CONFINEMENT FUSION DEVICES
See ICF DEVICES

INFLATIONARY UNIVERSE
Gravitational couplings of the inflaton in extended inflation, 15:33286 (R;US)
Soft inflation, 15:33288 (R;US)
Stability of compactification during inflation, 15:33287 (R;US)
Topological defects in extended inflation, 15:33291 (R;US)

INFORMATION SYSTEMS
Energy conservation program evaluation: Practical methods, useful results: Proceedings: Volume 2, August 20 and 21 sessions, 15:32479 (R;US)

INFRARED RADIATION
Health-hazard evaluation report HETA 88-229-1985, Ormet Corporation, Hannibal, Ohio, 15:33258 (R;US)

INHOMOGENEOUS PLASMA
Computer simulation of Alfven wave heating, 15:33795 (J;US)
Mode conversion between Alfven wave eigenmodes in axially inhomogeneous two-ion-species plasmas, 15:33796 (J;US)

INJECTION (BEAMS)
See BEAM INJECTION

INJECTION WELLS
A comparison of pressure-transient and tracer-concentration/time data for layered reservoirs under injection, 15:32134 (J;US)

INPUT WELL
See INJECTION WELLS

INSOLATION
Solar resources, 15:32278 (B;US)

INSTRUMENTS (MEASURING)
See MEASURING INSTRUMENTS

INSULATING LIMITERS
See LIMITERS

INSULATION (ELECTRICAL)
See ELECTRICAL INSULATION

INTEGRAL EQUATIONS
Solution of the Stokes system by boundary integral equations and fixed point iterative schemes, 15:33687 (R;XA)

INTEGRALS
Asymptotics of Laplace-Dirichlet integrals, 15:33693 (R;XA)
Product integration rules at Clenshaw-Curtis and related points: A robust implementation, 15:33682 (R;XA)
Weighted norm inequalities for Riemann-Liouville fractional integral, 15:33677 (R;XA)

INTEGRATED CIRCUITS
Metal silicides formed by direct ion beam deposition, 15:32627 (BA;US)
Thermal emission model for the anneal of radiation-induced trapped holes, 15:32985 (R;US)

INTEGRITY(FUEL)
See FUEL INTEGRITY

INTERFACES
Atomic scale imaging of the structure and chemistry of semiconductor interfaces, 15:32698 (R;US)
Electron microscopy of interfaces in silicon carbide whisker-reinforced alumina composites, 15:32699 (R;US)
Turbulent energy at accelerating and shocked interfaces, 15:33390 (J;US)

INTERFEROMETERS
See also MICHELSON INTERFEROMETER
A diagnostic for 2D density profiles in Heliac H-1, 15:33728 (RA;AU)
A novel scanning interferometer for two-dimensional plasma density measurements, 15:33730 (R;AU)
Automatic, high-resolution analysis of low-noise fringes, 15:32992 (R;US)

INTERFEROMETRY
A convenient system for diffraction moire measurements, 15:32991 (R;US)

INTERNAL COMBUSTION ENGINES
See also DIESEL ENGINES
GAS TURBINE ENGINES
Combustion of n-butane and isobutane in an internal combustion engine: A comparison of experimental and modeling results, 15:32520 (R;US)
Diagnostic tools for reciprocating engine cogeneration systems. Phase 1, final report, June 1989-December 1989, 15:32508 (R;US)
Engine knock predictions using a fully-detailed and a reduced chemical kinetic mechanism, 15:32519 (R;US)
Engine turbochargers and superchargers. January 1983-January 1990 (A Bibliography from the COMPENDEX data base). Report for January 1983-January 1990, 15:32518 (R;US)

INTERNATIONAL ATOMIC ENERGY AGENCY
See IAEA

INTERSTELLAR SPACE
The disk-halo connection and the nature of the interstellar medium, 15:33298 (R;US)

ION BEAMS
A high charge state multicusp ion source, 15:32956 (J;US)
Analysis of the ion beam obtained from a small multicusp ion source, 15:32955 (J;US)
Microstructural studies of IAD and PVD Cr coatings by cross section transmission electron microscopy, 15:32734 (BA;US)
Relativistic heavy ions from the BNL [Brookhaven National Laboratory] booster medical research and technological applications, 15:32907 (R;US)
SIMION PC/PS2 electrostatic lens design program, 15:33361 (J;US)
Sources of multiply charged ions for heavy-ion fusion, 15:33801 (J;US)
Sources of spin-polarized beams (invited), 15:32958 (J;US)
Unlubricated sliding properties of ion beam and excimer laser mixed Fe-Ti-C multilayered films, 15:32649 (BA;US)

ION CYCLOTRON-RESONANCE HEATING
See ICR HEATING

ION EXCHANGE MATERIALS
See also ORGANIC ION EXCHANGERS
Improvements in macroreticular particles for ion-exchange and gel-permeation chromatography, 15:32700 (R;US)
Polymer-based separations: Synthesis and application of polymers for ionic and molecular recognition: Annual performance report, August 1, 1989–July 31, 1990, 15:32702 (R;US)
West Valley Demonstration Project annual report to Congress, 15:32243 (R;US)

ION EXCHANGE MEMBRANES
See ION EXCHANGE MATERIALS
MEMBRANES

ION SOURCES
An autoneutralizing neutral molecular beam gun, 15:33362 (J;US)
Analysis of the ion beam obtained from a small multicusp ion source, 15:32955 (J;US)
Broad-beam multi-ampere metal ion source, 15:33353 (J;US)
ERC sources for the production of highly charged ions (invited), 15:32952 (J;US)
Electron cyclotron resonance ion source frequency scaling and radial confinement in a quadrupole magnetic field, 15:32954 (J;US)
H^0 temperature and density measurements in a Penning surface-plasma H^- ion source. I., 15:33792 (J;US)
High-intensity plasma-sputter heavy negative-ion source (invited), 15:32957 (J;US)
Ion spectra of the metal vapor vacuum arc ion source with compound and alloy cathodes, 15:33354 (J;US)
Multiple arc ion sources for heavy ion fusion, 15:33833 (J;US)
Operating experience with the Argonne PIIECR ion source system, 15:32928 (J;US)
Operational characteristics of a metal vapor vacuum arc ion source, 15:33355 (J;US)
Solid state cesium ion guns for surface studies, 15:33363 (J;US)
Testing of a H_2^+-enriched ion source for deuterium simulation, 15:33349 (J;US)
The KSU cryogenic electron-beam ion source, 15:32953 (J;US)
The LLNL [Lawrence Livermore National Laboratory] ion source: Past, present and future, 15:32944 (R;US)

ION-ATOM COLLISIONS
Calculation of positron spectra from heavy-ion collisions and study of the line structure, 15:33329 (R;DE;In German)
Convoy electrons, 15:33616 (R;US)
Correlated positron-electron emission in heavy-ion collisions at the Coulomb barrier, 15:33330 (R;DE)
Mass systematics of hypothetical neutral objects in heavy-ion collisions and in e^+ heavy-ion interactions, 15:33336 (R;JP)
Nuclear-charge screening in electron capture, 15:33375 (J;US)

ION-ION COLLISIONS
Time evolution of the mass exchange in grazing heavy-ion collisions, 15:33341 (R;HU)

ION-MOLECULE COLLISIONS
Angular distribution of Auger electrons and photons in resonant transfer and excitation in collisions of ions with light targets, 15:33364 (J;US)

IONIC REACTIONS
See IONS

IONIZATION CALORIMETERS
See SHOWER COUNTERS

IONIZATION LOSS
See ENERGY LOSSES

IONIZING RADIATIONS
See also COSMIC RADIATION
GAMMA RADIATION
Interaction of ionizing radiation with matter, 15:32830 (BA;US)

IONS
See also ARGON IONS
ATOMIC IONS
CARBON IONS
CESIUM IONS
DEUTERIUM IONS
FLUORINE IONS
GOLD IONS
HEAVY IONS
HELIUM IONS
HYDROGEN IONS
IRON IONS
MOLYBDENUM IONS
MULTICHARGED IONS
NICKEL IONS
NITROGEN IONS
OXYGEN IONS
SELENIUM IONS
SILICON IONS
SULFUR IONS
TITANIUM IONS
URANIUM IONS
XENON IONS
ZINC IONS
The electron: Its properties and reactions, 15:33343 (BA;US)

IONS (ATOMIC)
See ATOMIC IONS

IRIDIUM
Trapping-mediated dissociative chemisorption of ethane on Ir(110)-(1 x 2), 15:32820 (J;US)

IRIDIUM SILICIDES
Effect of transition-metal substitutions on competing electronic transitions in the heavy-electron compound URu_2Si_2, 15:32761 (J;US)

IRON
Dynamical information for Fe doped $YBa_2Cu_3O_7$ superconducting oxides obtained from high temperature Moessbauer studies, 15:32602 (R;BR)
National Performance Audit Program: Acid rain audits, 1988, 15:33082 (R;US)

IRON 56 TARGET
Observation of double isovector giant dipole resonances from pion double charge exchange, 15:33535 (J;US)

IRON 57
Local oxygen configurations relative to $F_e$probe ions in $HoBa_2{}^{Cu}{}_{0.95}{}^{Fe}{}_{0.053}{}^{O}{}_{7-x}$, 15:32663 (BA;US)
IRON ALLOYS
See also ALLOY-NI49CR22FE18MO9
HAVAR
IRON BASE ALLOYS
Annealing studies of B2FeAl, 15:32586 (BA;US)
Ion-beam mixing in amorphous and crystalline Fe-Ti, 15:32568 (BA;US)
Phase and microstructure of Fe modified Al_3Ti, 15:32585 (BA;US)
Study of metal corrosion using ac impedance techniques in the STS launch environment, 15:32549 (RA;US)
IRON BASE ALLOYS
See also STEELS
Melting of iron-aluminide alloys, 15:32044 (R;US)
Morphological and structural characterization of the spinodal decomposition of Fe-Cr alloys, 15:32536 (R;US)
[Neutron scattering studies of spatial correlations in Fe-V and Fe-Cr alloys]: Foreign trip report, September 30, 1989–April 23, 1990, 15:32554 (R;US)
[Oxidation of intermetallics and ceramics]: Foreign trip report, March 23, 1990–April 12, 1990, 15:32553 (R;US)
IRON CARBIDES
Unlubricated sliding properties of ion beam and excimer laser mixed Fe-Ti-C multilayered films, 15:32649 (BA;US)
IRON IONS
Correlation enhancement of the electron-impact ionization cross section for excited-state Ne-like ions, 15:33370 (J;US)
Moessbauer spectroscopy study of the kinetics of photoreduction of Fe^{3+} on CdS semiconductor powders, 15:32762 (J;US)
IRON OXIDES
Orbital polarization and the insulating gap in the transition-metal oxides, 15:32673 (J;US)
ISING MODEL
Quantum Ising model on hierarchical structures, 15:33624 (R;XA)
ISOMERS
Gas-phase heats of formation of $C_7H_7{}^+$ isomers: M-tolyl, p-tolyl, and benzyl ions, 15:32822 (J;US)
ISOTOPE APPLICATIONS
Application of AMS [accelerator mass spectrometry] to the biomedical sciences, 15:33196 (R;US)
ISOTOPE ENRICHMENT
See ISOTOPE SEPARATION
ISOTOPE SEPARATION
CCS-I: a code to analyze a dynamic behavior of uranium enrichment process in a centrifuge cascade: An application to the safeguards effectiveness assessment, 15:33847 (R;JP)
ISOTOPIC SEPARATION
See ISOTOPE SEPARATION
ITALY
Development of a hydrogen mitigation strategy for degraded core accidents in a BWR/6 - Mark III power plant, 15:32385 (RA;US)
ITER TOKAMAK
Computer simulation of the interaction of LH waves with thermonuclear alpha particles, 15:33754 (RA;CS)
ITERATIVE METHODS
See also GALERKIN-PETROV METHOD
NEWTON METHOD
PCGPAK for message passing multiprocessors. Final report on Phase 1, 15:33851 (R;US)
Solving large sparse linear systems of equations in a global shared-memory multiprocessing environment. Final report on Phase 1, 15:33852 (R;US)

J

J PSI-3097 MESONS
Study of the doubly radiative decay $J/\psi \to \gamma\gamma\rho^0$, 15:33423 (J;US)
A dependence of J/ψ production in π^--nucleus collisions at 530 GeV/*c*, 15:33411 (J;US)
J-3105 RESONANCES
See J PSI-3097 MESONS
JAPAN
Experimental study for structural behavior of reinforced concrete containment vessel beyond design pressure, 15:32390 (RA;US)
Proving Test on the Reliability for Reactor Containment Vessel, 15:32388 (RA;US)
Public perception and acceptance of the siting of nuclear waste facilities in seven countries, 15:32218 (R;US)
JAPAN POWER DEMONSTRATION REACTOR
See JPDR REACTOR
JAPANESE ORGANIZATIONS
Annual report, 1988. 4 - 1989. 3, 15:33721 (R;JP;In Japanese)
JET ENGINE FUELS
Jet fuels potential of liquid by-products from the Great Plains Gasification Project, 15:32048 (R;US)
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 17, April 1–June 30, 1988, 15:32062 (R;US)
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 23, July 1–September 30, 1988, 15:32063 (R;US)
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 25, October 1–December 31, 1988, 15:32064 (R;US)
Production of jet fuel from coal-derived liquids: Quarterly technical progress report No. 29, January 1–March 31, 1989, 15:32065 (R;US)
Production of jet fuel from coal-derived liquids: Report No. 16: Quarterly technical progress report, second quarter FY 1988, January 1, 1988–March 31, 1988, 15:32061 (R;US)
Production of jet fuels from coal derived liquids: Volume 6, Preliminary analysis of upgrading alternatives for the Great Plains liquid by-product streams: Interim report, March 1987–February 1988, 15:32058 (R;US)
Production of jet fuels from coal derived liquids: Volume 9, Results of bench-scale testing and pilot plant testing: Interim report, February 1988–March 1989, 15:32059 (R;US)
Production of jet fuels from coal-derived liquids: Volume 12, Preliminary process design and cost estimate and production run recommendation: Final report, March 1989–December 1989, 15:32060 (R;US)
Superfund Record of Decision (EPA Region 2): FAA (Federal Aviation Administration) Technical Center, Atlantic County, New Jersey (First remedial action), September 1989, 15:32156 (R;US)
JET MODEL
Searching for *CP* violation in "charge-blind" jets, 15:33483 (J;US)
Studies on the separation between higher-twist and minimum-twist in the photoproduction experiment WA69 at the CERN-OMEGA spectrometer, 15:33427 (R;DE;In German)
JET REACTORS
See JET TOKAMAK
JET TOKAMAK
Equilibrium configuration for a high current pumped divertor, 15:33769 (RA;GB)
Experimental evidence from present X-point operation in JET, 15:33767 (RA;GB)
JET contributions to the workshop on the new phase for JET: the pumped divertor proposal, 15:33764 (R;GB)
Modelling the pumped divertor, 15:33766 (RA;GB)
Modification to the lower hybrid system, 15:33775 (RA;GB)
The JET cryopump, 15:33772 (RA;GB)
The new phase for JET and its objective, 15:33765 (RA;GB)
The overall configuration, 15:33768 (RA;GB)
JETS
Modeling jet penetration in glass, 15:33033 (R;US)
JFT-2 TOKAMAK
A study on the heating and diagnostic of a tokamak plasma by electromagnetic waves of the electron cyclotron range of frequencies, 15:33763 (R;JP;In Japanese)
JFT-2M TOKAMAK
A study on the heating and diagnostic of a tokamak plasma by electromagnetic waves of the electron cyclotron range of frequencies, 15:33763 (R;JP;In Japanese)

JPDR REACTOR
Determination of the long-lived nuclides in biological shielding concrete, ion exchange resin and fuel storage pool water of JPDR, 15:32371 (R;JP;In Japanese)
JUNCTIONS (SEMICONDUCTOR)
See SEMICONDUCTOR JUNCTIONS

K

K-25 PLANT
See ORGDP
K02
See KAONS NEUTRAL LONG-LIVED
KANSAS
Superfund Record of Decision (EPA Region 7): Arkansas City Dump Site, Arkansas City, Kansas (Second remedial action), September 1989. Final report, 15:32155 (R;US)
KANSAS CITY PLANT
Tiger Team environment, safety, and health assessment of the Kansas City Plant, 15:33120 (R;US)
KAON MINUS REACTIONS
Crossing-consistent analysis of kaon photoproduction and radiative capture, 15:33594 (J;US)
The relative probability for the recoilless Λ-production in nuclei in the plane wave impulse approximation, 15:33568 (R;XA)
KAON MINUS-PROTON INTERACTIONS
A summary of the results from LASS [Large Aperture Superconducting Solenoid] and the future of strange quake spectroscopy, 15:33410 (R;US)
KAONS
See also KAONS PLUS
Measurement of D^* production in jets from $\bar{p}p$ collisions at $\sqrt{s}$ =1.8 TeV, 15:33413 (J;US)
KAONS 2
See KAONS NEUTRAL LONG-LIVED
KAONS NEUTRAL LONG-LIVED
Comment on phenomenology of the almost standard model, 15:33439 (R;XA)
Kaon rare decays, 15:33403 (RA;JP)
Vector-meson contributions to the processes $\gamma\gamma \to \pi^0\pi^0, \pi^+\pi^-$, $K_L \to \pi^0\gamma\gamma$, and $K^+ \to \pi^+\gamma\gamma$, 15:33465 (J;US)
KAONS PLUS
Crossing-consistent analysis of kaon photoproduction and radiative capture, 15:33594 (J;US)
Kaon rare decays, 15:33403 (RA;JP)
Vector-meson contributions to the processes $\gamma\gamma \to \pi^0\pi^0, \pi^+\pi^-$, $K_L \to \pi^0\gamma\gamma$, and $K^+ \to \pi^+\gamma\gamma$, 15:33465 (J;US)
KAPPA-725 RESONANCES
See MESONS
KEK INTERS. STORAGE ACCELERATOR
See TRISTAN STORAGE RINGS
KEK PHOTON FACTORY
The shielding design methods of the synchrotron radiation facility, 1: Accelerator, 15:32935 (R;JP;In Japanese)
KENTUCKY
Air toxics compliance issues and case histories from the Kentucky experience, 15:32450 (BA;US)
KEROGEN
Comparison of isothermal and nonisothermal pyrolysis data with various rate mechanisms: Implications for kerogen structure, 15:32166 (BA;US)
KINEMATICS (PARTICLE)
See PARTICLE KINEMATICS
KINK INSTABILITY
Influence of an energetic ion population on tokamak plasma stability, 15:33793 (J;US)
KLEIN-GORDON EQUATION
Continuum states of the Klein-Gordon equations for vector and scalar interactions, 15:33668 (R;XA)
KNOCK-ON ELECTRONS
See ELECTRONS
KRYPTON
Precipitation of Ar, Kr and Xe in Ni at room temperature, 15:32730 (BA;US)
KRYPTON 86 REACTIONS
Three paths for intermediate-mass fragment formation at a near-onset excitation energy of 1.3 MeV/nucleon, 15:33538 (J;US)
KUR REACTOR
Summary reports of activities under visiting research program in Research Reactor Institute, Kyoto University, 1988, 15:32354 (R;JP;In Japanese)
KYOTO UNIVERSITY REACTOR
See KUR REACTOR

L

LABELLED COMPOUNDS
Ordered synthesis and mobilization of glycogen in the perfused heart, 15:33205 (J;US)
LAGRANGE FIELD EQUATIONS
See LAGRANGIAN FIELD THEORY
LAGRANGIAN
See LAGRANGIAN FUNCTION
LAGRANGIAN FIELD THEORY
Relativistically covariant projection formalism for an interacting quantum field theory, 15:33484 (R;DE)
The sewing technique for strings and conformal field theories, 15:33509 (R;DK)
LAGRANGIAN FUNCTION
A simple Lagrangian for integrable systems, 15:33716 (J;US)
LAMBDA NEUTRAL
See LAMBDA PARTICLES
LAMBDA PARTICLES
See also ANTILAMBDA PARTICLES
The reaction anti pp → anti ΛΛ 92 MeV above the reaction threshold, 15:33402 (R;DE;In German)
LAND FILLS
See SANITARY LANDFILLS
LAND POLLUTION
Comparison of an unsaturated soil zone model (SESOIL) predictions with a laboratory leaching experiment, 15:33136 (BA;US)
LAND USE
Computerized data-base system for land-use and land-cover data collected at ground-water sampling sites in the pilot National Water-Quality Assessment Program. Water-Resources Investigation, 15:33152 (R;US)
LANDFILLS
See SANITARY LANDFILLS
LANGEVIN EQUATION
Convergence of the Langevin simulation for complex Gaussian integrals, 15:33523 (J;US)
LANGMUIR PROBE
Electrostatic edge turbulence on CASTOR tokamak, 15:33751 (RA;CS)
LANTHANIDES
See RARE EARTHS
LANTHANUM
Electron spectroscopic investigation of atomic 4d giant resonances for Ba, La and lanthanides, 15:33331 (R;DE;In German)
LANTHANUM 140
Interacting-boson-fermion-fermion model description of $^{140}La_{83}$ and comparison with levels populated by beta decay and neutron capture, 15:33547 (J;US)
LANTHANUM CHROMITES
See LANTHANUM OXIDES
LANTHANUM COMPOUNDS
See also LANTHANUM OXIDES
Elastic constants and specific-heat measurements on single crystals of La_2CuO_4, 15:32679 (J;US)
High-temperature defect structure of Nb-doped $LaCrO_3$, 15:32669 (J;US)
LANTHANUM OXIDES
$La_2CuO_{4+\delta d}$ and $La_2NiO_{4+\delta d}$: Phase separation resulting from excess oxygen defects, 15:32619 (BA;US)

Magnetic and pairing correlations in a three band Hubbard model, 15:32646 (BA;US)
O 2*p* holes: Temperature effects and surface characteristics of cuprate superconductors, 15:32689 (J;US)
Orbital polarization and the insulating gap in the transition-metal oxides, 15:32673 (J;US)
Phase separation in a high-pressure-oxygenated $La_2CuO_{4+\delta}$ crystal: Evidence from anisotropic electronic transport and magnetic susceptibility, 15:32683 (J;US)
S-N-S behavior of grain boundaries in polycrystalline $La_{1.85}Sr_{0.15}CuO_{4-y}$, 15:32901 (BA;US)
Superconductivity and magnetism in $La_2CuO_{4+\delta}$ by μSR, 15:32633 (BA;US)

LASER DOPPLER ANEMOMETERS
See ANEMOMETERS

LASER GUIDANCE
Laser-guidance systems, security classification. Instruction, 15:33016 (R;US)

LASER POWER TRANSMISSION
Power-transmission device, 15:32433 (P;US)

LASER TARGETS
A review of self generated B-field in ICF corona, 15:33816 (R;XA)
Temporal behaviour of self generated magnetic field and its influence on inhibition of thermal flux in ICF plasma, 15:33815 (R;XA)

LASER-PRODUCED PLASMA
CW ultraviolet and visible laser action from ionized silver in an electron beam generated plasma, 15:33790 (J;US)

LASER-RADIATION HEATING
Electron beam induced emission from carbon plasmas, 15:33828 (BA;US)

LASERS
See also FREE ELECTRON LASERS
GAS LASERS
X-RAY LASERS
Measurement of the ion temperature in the tokamak TCA by collective Thomson diffusion in the far infrared, 15:33784 (R;CH;In French)
Multichip packaging technology with laser-patterned interconnects, 15:32714 (R;US)
Review of long-pulse laser development, 15:32894 (BA;US)
Security classification of information concerning high-energy lasers. Instruction, 15:33017 (R;US)

LATTICE DEFECTS
See CRYSTAL DEFECTS

LATTICE FIELD THEORY
Electroweak BAU generation on the lattice: Real time vs. Euclidean approach, 15:33507 (R;DK)
Non-Abelian gauge theory on a finite-element lattice, 15:33522 (J;US)
The first order phase transition for six-state Potts model on 2-dimensional random triangle lattice, 15:33489 (R;XA)

LATTICES (CRYSTAL)
See CRYSTAL LATTICES

LAUSANNE TOKAMAK
See TCA TOKAMAK

LAWRENCE LIVERMORE LABORATORY
LLNL/UC [Lawrence Livermore National Laboratory]/[University of California] AMS [accelerator mass spectrometry] facility and research program, 15:32941 (R;US)
The new LLNL AMS spectrometer, 15:32942 (R;US)

LEACHATES
The application of expandable polystyrene pellets as filter media to controlled filter in a uranium mill, 15:32193 (R;CN;In Chinese)

LEAD
Concentrations of metals in Norton Sound seawater samples and human hair samples, 1989, 15:33188 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 4. Primary zinc, primary lead, secondary lead, primary antimony. Final report, 15:33157 (R;US)
Health assessment for Beachwood Borough and Berkeley Township National Priorities List (NPL) Site, Ocean County, New Jersey, Region 2. CERCLIS No. NJD980654123. Final report, 15:33142 (R;US)
Health-hazard evaluation report HETA 87-371-1986, technical assistance to the Jamaican Ministry of Health, Kingston, Jamaica, 15:33239 (R;US)
Health-hazard evaluation report HETA 87-371-1989, technical assistance to the Jamaican Ministry of Health, Kingston, Jamaica, 15:33075 (R;US)
Holographic measurement of ejecta from shocked metal surfaces, 15:32874 (BA;US)
National Performance Audit Program: Acid rain audits, 1988, 15:33082 (R;US)
A dependence of highly inelastic *p*-nucleus collisions, 15:33418 (J;US)
A dependence of J/ψ production in π^--nucleus collisions at 530 GeV/*c*, 15:33411 (J;US)

LEAD 208
Analyzing powers for $\vec{p}+^{208}$Pb at large momentum transfers, 15:33557 (J;US)
Heavy-ion Coulomb excitation and photon decay of the giant dipole resonance in ^{208}Pb, 15:33554 (J;US)

LEAD 208 TARGET
Analyzing powers for $\vec{p}+^{208}$Pb at large momentum transfers, 15:33557 (J;US)
Coulomb-dissociation of 156 MeV ^{6}Li-projectiles, 15:33553 (R;DE;In German)
Coulomb-nuclear interference in pion inelastic scattering, 15:33556 (J;US)
Heavy-ion Coulomb excitation and photon decay of the giant dipole resonance in ^{208}Pb, 15:33554 (J;US)

LEAD OXIDES
Chemistry and superconducting behavior of Sb-substituted Bi/Pb-based oxides, 15:32626 (BA;US)

LEAD ZIRCONITE TITANATE
See PZT

LEAD-ACID BATTERIES
Application of ultracapacitors in electric vehicle propulsion systems, 15:32523 (R;US)
Laboratory testing of chloride 3ET205 6 volt traction battery, 15:32438 (R;US)

LECTINS
[Hydroxyproline-rich glycoproteins of the plant cell wall]: Progress report, June 1989–June 1990, 15:33193 (R;US)

LEP STORAGE RINGS
Digital control of the LEP RF system, 15:32963 (BA;US)

LEPTON-DEUTERON INTERACTIONS
See DEUTERIUM TARGET

LEPTONS
See also ELECTRONS
NEUTRINOS
Hadron-collider limits on new electroweak interactions from the heterotic string, 15:33454 (J;US)
Nonperturbative QED and loop bremsstrahlung of neutral lepton pairs in heavy-ion collisions, 15:33525 (J;US)

LEUKEMIA
Expert systems for flow cytometry data analysis: A preliminary report, 15:33214 (R;US)
NIOSH (National Institute for Occupational Safety and Health) Testimony on the safety of nuclear facility workers by P. J. Bierbaum on April 22, 1985, 15:32255 (R;US)

LIABILITIES
General report of the Insurance Study Committee, 15:32367 (R;IT)
Risks and nuclear insurance, 15:32368 (R;IT)

LIE GROUPS
The center of the enveloping algebra of the semidirect product of the Heisenberg Lie algebra h_n and a reductive lie algebra S the rank of which is equal to 1 or 2, 15:33679 (R;XA)

LIGHT GUIDES
See OPTICAL FIBERS

LIGHT SOURCES
Measurements of Smith–Purcell radiation, 15:32997 (J;US)

LIGHT WATER COOLED REACTORS
See WATER COOLED REACTORS

LIGHTING SYSTEMS
Energy conservation through mechanical dehumidification Miramicki Valley High School pool, Newcastle, N.B.: Final report, 15:32515 (R;CA)
LIGHTNING
On the dynamics of severe thunderstorms, 15:33059 (R;XA)
LIGHTNING ARRESTERS
The response of MOV and SiC arresters to steep-front longer duration current pulses, 15:32434 (R;US)
LIGNIN
[Conversion of acetic acid to methane by thermophiles]: Progress report, May 15, 1985–May 15, 1990, 15:32267 (R;US)
LIGNITE
Coal-water interactions and preparation of dewatered ultrafine clean coal, 15:32038 (RA;US)
On the nature of organosulfur constituents in Rasa lignite, 15:32107 (BA;US)
Organic petrography, and organic geochemistry of Texas Tertiary coals in relation to depositional environment and hydrocarbon generation, 15:32082 (R;US)
Simultaneous SO_x/NO_x control: Technical report, April 1, 1987–March 31, 1988 including Quarterly technical progress report, January–March 1988, 15:32310 (R;US)
LIMESTONE
Transport studies of radon in limestone underlying houses, 15:33118 (R;US)
LIMITERS
Modeling of runaway electron damage for the design of tokamak plasma facing components, 15:33822 (R;US)
LINACS
See LINEAR ACCELERATORS
LINEAR ACCELERATORS
See also CEBAF ACCELERATOR
LLNL ADVANCED TEST ACCELERATOR
STANFORD LINEAR COLLIDER
Beam position monitors for the CESR linac, 15:32962 (BA;US)
High average-power induction linacs, 15:32912 (BA;US)
Operating experience with the Argonne PIIECR ion source system, 15:32928 (J;US)
LINERS
3-D FEM analysis of 1:6 scale reinforced concrete containment under static overpressurization and local analysis of liner plant tearing, 15:32401 (RA;US)
Post-test analysis of a piping penetration in a 1:6-scale model of a reinforced concrete containment building, 15:32400 (RA;US)
Some post-test analyses of the 1/6th Sandia containment, 15:32396 (RA;US)
LIPIDS
Determination of lattice structure and calculation of molecular tilt in lipid monolayers on water using x-ray diffraction, 15:32777 (J;US)
LIQUID ASPHALT
See PETROLEUM RESIDUES
LIQUID COLUMN CHROMATOGRAPHY
Fundamental studies with a monodisperse aerosol-based liquid chromatography/mass spectrometry interface (MAGIC-LC/MS): Progress report, September 1, 1985–November 30, 1989, 15:32783 (R;US)
LIQUID CRYSTALS
Liquid crystal coatings for surface shear stress visualization in hypersonic flows, 15:32709 (R;US)
LIQUID EFFLUENTS
See LIQUID WASTES
LIQUID FLOW
Studies of the analyte-carrier interface in flow injection analysis: Project report, June 1, 1987–December 1, 1989, 15:32784 (R;US)
LIQUID METAL COOLANT
See LIQUID METALS
LIQUID METALS
Thermodynamics and structure of liquid alkali metals from the charged-hard-sphere reference fluid, 15:32805 (R;XA)
LIQUID SCINTILLATION DETECTORS
Altitude-velocity envelope for a moving neutron detector, 15:32980 (R;US)
LIQUID SCINTILLATORS
Rapid determination of plutonium content on filters and smears using Alpha Liquid Scintillation, 15:32974 (R;US)
LIQUID WASTES
See also WASTE WATER
West Valley Demonstration Project annual report to Congress, 15:32243 (R;US)
LIQUID-PHASE SINTERING
See SINTERING
LIQUIDS
See also COAL LIQUIDS
LIQUID CRYSTALS
LIQUID METALS
A composition density functional theory for mixtures based upon an infinitely polydisperse reference. II. Freezing in hard sphere mixtures, 15:32819 (J;US)
A general solution of the molecular Ornstein–Zernike equation for spheres with anisotropic adhesion and electric multipoles, 15:33397 (J;US)
A perfluorocarbon tracer transport and dispersion experiment in the North Sea Ekofisk oil field: Revision, 15:33116 (R;US)
Drop oscillations in liquid-liquid systems, 15:32872 (J;US)
LITHIUM
Core-level photoemission from alkali metals on Ru(001), 15:32594 (J;US)
LITHIUM 11
Quasifree fragmentation of radioactive projectiles: Extended Serber model, 15:33592 (J;US)
LITHIUM 6
Coulomb-dissociation of 156 MeV ^{6}Li-projectiles, 15:33553 (R;DE;In German)
LITHIUM 6 REACTIONS
Coulomb-dissociation of 156 MeV ^{6}Li-projectiles, 15:33553 (R;DE;In German)
LITHIUM 6 TARGET
Charged-particle multiplicities following pion absorption on ^{6}Li, 15:33532 (J;US)
Forward scattering of a proton from a J=1 nucleus: Selection rules for flipping the spin of the target by two units, 15:33580 (J;US)
LITHIUM 7 TARGET
Multiconfiguration resonating-group theory of ^{8}Li, 15:33579 (J;US)
LITHIUM 8
Multiconfiguration resonating-group theory of ^{8}Li, 15:33579 (J;US)
LITHIUM OXIDES
Calculation of ion channeling directions in low symmetry optical materials, 15:32643 (BA;US)
Electronic structure and optical properties of LiB_3O_5, 15:32696 (J;US)
Ion implantation of Ti into $LiNbO_3$: Fabrication of waveguides and simple modulators, 15:32995 (BA;US)
LLNL ADVANCED TEST ACCELERATOR
Optical Cherenkov measurements of emittance growth in the Advanced Test Accelerator beam under laser ion-guiding, 15:32946 (BA;US)
Time-dependent degradation of an ion-focused ATA beam, 15:32926 (BA;US)
LMFBR TYPE REACTORS
Advanced Liquid Metal Reactor site selection criteria report, 15:32348 (R;US)
Critical experiment tests of bowing and expansion reactivity calculations for liquid-metal-cooled fast reactors, 15:32428 (J;US)
Experiments and analysis for large conventional fast reactors in ZPPR-18/19, 15:32326 (R;US)
Reference site selection report for the advanced liquid metal reactor at the Idaho National Engineering Laboratory, 15:32347 (R;US)
LOAD (DYNAMIC)
See DYNAMIC LOADS

LOCA
See LOSS OF COOLANT
LOCAL GALAXY
See MILKY WAY
LOCAL GROUP
See GALAXIES
LOFT REACTOR
Highlights of the OECD [Organization for Economic Cooperation and Development] LOFT [Loss-of-Fluid Test] LP-FP-2 experiment including hydrogen generation, fission product chemistry, and transient fission product release fractions, 15:32346 (R;US)
LONGITUDINAL PINCH
K-lines in soft X-ray spectrum and the determination of plasma parameters of Ar Z-pinch, 15:33749 (RA;CS)
LOS ANGELES
Southern California Air Quality Study (SCAQS) description of measurement activities. Final report, 15:33093 (R;US)
LOSS OF COOLANT
Data report for ROSA-IV LSTF 5% hot leg break experiment Run SB-HL-01, 15:32372 (R;JP)
Development of a PIRT (phenomena identification and ranking table) for a postulated double-ended guillotine break in a production reactor, 15:32359 (R;US)
Modelling of the steam-water-countercurrent flow in the rewetting and flooding phase after loss-of-coolant accidents in pressurized water reactors, 15:32366 (R;DE;In German)
Ranking significant phenomena in physical systems, 15:32358 (R;US)
LOSS OF FLUID TEST REACTOR
See LOFT REACTOR
LOSSES (ENERGY)
See ENERGY LOSSES
LOVIISA-1 REACTOR
Ice melting progress in a nonuniformly loaded ice condenser facility, 15:32383 (RA;US)
LOW-BETA PLASMA
The ion temperature gradient instability in a linear machine, 15:33797 (J;US)
LOW-LEVEL RADIOACTIVE WASTES
FUETAP concrete, 15:32250 (BA;US)
Geohydrology of the 218-W-5 Burial Ground, 200-West Area, Hanford Site, 15:32231 (R;US)
Low-level radioactive waste management in the United States, 15:32252 (BA;US)
Proceedings of the US Department of Energy Office of Environmental Restoration and Waste Management waste reduction workshop 4, 15:32204 (R;US)
Program for low-level radiactive waste disposal at the Savannah River Site, a U.S. nuclear materials production facility, 15:32248 (BA;US)
Results of field testing of waste forms using lysimeters, 15:32217 (R;US)
Special Wasteform Lysimeter Program wasteform characteristics, 15:32214 (R;US)
Treatment and destruction of hazardous chemical wastes, 15:33106 (R;US)
LOWER HYBRID HEATING
Computer simulation of the interaction of LH waves with thermonuclear alpha particles, 15:33754 (RA;CS)
Modification to the lower hybrid system, 15:33775 (RA;GB)
On the application of the nonlinear reflection coefficient theory to some lower hybrid experimental results on PLT tokamak, 15:33759 (RA;CS)
LOWER HYBRID RESONANCE HEATING
See LOWER HYBRID HEATING
LUBRICANTS
On-line monitor for metallic wear products. Phase 1. Final report, 15:32260 (R;US)
LUNAR MATERIALS
^{10}Be profiles in lunar surface rock 68815, 15:33316 (BA;US)
Cordierite-spinel troctolite, a new magnesium-rich lithology from the lunar highlands, 15:33283 (J;US)
Transportation and operations aspects of space energy systems, 15:32263 (RA;US)
LUNGS
Biological effects of combined exposure to coal fly ash and nitrogen dioxide, 15:32122 (R;JP;In Japanese)
NIOSH (National Institute for Occupational Safety and Health) testimony on asbestos by R. A. Lemen on March 21, 1984, 15:33237 (R;US)
Review, discussion, and summary: Toxicology, 15:33248 (R;US)
LWR TYPE REACTORS
See WATER COOLED REACTORS
LYSIMETERS
Field Lysimeter Test Facility: Second year (FY 1989) test results, 15:32228 (R;US)

M

MA 754
See NICKEL BASE ALLOYS
MA 956
See IRON BASE ALLOYS
MACHINE PARTS
Apple interface for experimental instrumentation and control-Pulse counter, timer, digital-to-analog converter, step motor and relays, 15:33004 (R;BR;In Portuguese)
MACROPHAGES
Morphological and biochemical investigations into the effects of quartz on bovine alveolar macrophages (BAM) and their organelles, 15:33232 (R;DE;In German)
MAGNESIUM COMPOUNDS
Cordierite-spinel troctolite, a new magnesium-rich lithology from the lunar highlands, 15:33283 (J;US)
MAGNETIC FIELD CONFIGURATIONS
See also MAGNETIC ISLANDS
MAGNETIC SURFACES
Experimental studies on drift waves in SHEILA, 15:33729 (RA;AU)
MAGNETIC FIELDS
See also GEOMAGNETIC FIELD
Electron cyclotron resonance ion source frequency scaling and radial confinement in a quadrupole magnetic field, 15:32954 (J;US)
Health-hazard evaluation report HETA 88-229-1985, Ormet Corporation, Hannibal, Ohio, 15:33258 (R;US)
Investigation of effects of 60-Hz electric and magnetic fields on operant and social behavior and on the neuroendocrine system of nonhuman primates: Annual report, 15:32435 (R;US)
MAGNETIC FLUX
Nonlinear effects in a plasma with structured magnetic fields, 15:33758 (RA;CS)
MAGNETIC ISLANDS
Vacuum field optimization and the effects of field errors on the flux surfaces of the H-1 Heliac, 15:33803 (RA;AU)
MAGNETIC RECONNECTION
Three-dimensional kinematic reconnection in the presence of field nulls and closed field lines, 15:33321 (J;US)
MAGNETIC REFRIGERATORS
Magnetic heat pumps, 15:32499 (R;US)
Preparation, fabrication and properties of a rare earth intermetallic compound - GdPd, 15:32644 (BA;US)
MAGNETIC SURFACES
Electron beam measurements in SHEILA using a simple method of image intensification, 15:33727 (RA;AU)
MAGNETIC VORTICES
See MAGNETIC FLUX
MAGNETOHYDRODYNAMIC GENERATORS
See MHD GENERATORS
MAGNETOHYDRODYNAMICS
Tin-water magnetohydrodynamic electric power generator, 15:32475 (R;FR;In French)
MAGNETOSPHERE
See EARTH MAGNETOSPHERE

MAINE
Fiscal Year 1988 program report: Maine Environmental Studies Center, 15:32154 (R;US)
Transportation plan for the shuttle bus: Saco-Biddeford-Old Orchard Beach, 15:32494 (R;US)
MAINTENANCE
Maintenance and energy conservation - a pratical guide for energy , managers and maintenance engineers, 15:32498 (R;FR;In French)
MAIZE
CO_2 emissions from production and combustion of fuel ethanol from corn, 15:32270 (R;US)
MALIGNANCIES
See NEOPLASMS
MAN
Inhalation Toxicology Research Institute annual report, October 1, 1987–September 30, 1988, 15:33223 (R;US)
Inhalation Toxicology Research Institute annual report, October 1, 1988–September 30, 1989, 15:33224 (R;US)
[Radiological protection of the public from intakes of radionuclides]: Foreign trip report, April 21, 1990–April 27, 1990, 15:33225 (R;US)
MANGANESE
Health assessment for Beachwood Borough and Berkeley Township National Priorities List (NPL) Site, Ocean County, New Jersey, Region 2. CERCLIS No. NJD980654123. Final report, 15:33142 (R;US)
National Performance Audit Program: Acid rain audits, 1988, 15:33082 (R;US)
MANIPULATORS
Multi-criteria position and configuration optimization for redundant platform/manipulator systems, 15:32847 (R;US)
Optimal positioning of redundant manipulator-platform systems for maximum task efficiency, 15:32846 (R;US)
MANUALS
Review of overall safety manual for space nuclear systems: An evaluation of a nuclear safety analysis methodology for plutonium-fueled space nuclear systems, 15:32357 (R;US)
MANUFACTURERS
Case study of the regional manufacturers' participation in the manufactured housing RCDP [Residential Construction Demonstration Project], 15:32482 (R;US)
MANUFACTURING FACILITIES
See INDUSTRIAL PLANTS
MANY-BODY PROBLEM
Comments on relativistic correlation, 15:33346 (J;US)
QED potentials in many-electron atoms, 15:33350 (J;US)
MAR-250 ALLOY
See MARAGING STEELS
MARAGING STEELS
Ambient-temperature creep failure of silver-aided diffusion bonds between steel, 15:32558 (R;US)
MARIHUANA
The study of drugs of abuse with an ion trap mass spectrometer, 15:33216 (BA;US)
MARIJUANA
See MARIHUANA
MASS SPECTROMETERS
Determination of airborne organics by direct sampling mass spectrometry, 15:33050 (R;US)
Fundamental studies with a monodisperse aerosol-based liquid chromatography/mass spectrometry interface (MAGIC-LC/MS): Progress report, September 1, 1985–November 30, 1989, 15:32783 (R;US)
Injection systems for AMS: Simultaneous vs. sequential, 15:32943 (R;US)
Ion injection and ms/ms studies with a 3-dimensional quadrupole, 15:32795 (BA;US)
SIMION PC/PS2 electrostatic lens design program, 15:33361 (J;US)
The new LLNL AMS spectrometer, 15:32942 (R;US)
[Applied mass spectrometry in the health sciences]: Foreign trip report, April 15–April 21, 1990, 15:32788 (R;US)
MASS SPECTROSCOPY
Ion injection and ms/ms studies with a 3-dimensional quadrupole, 15:32795 (BA;US)
MASS TRANSIT SYSTEMS
Validation of "System 21" monobeam transit with computer analysis and large models: Final draft, 15:32491 (R;US)
MASSLESS PARTICLES
See also NEUTRINOS
PHOTONS
Limit on possible energy-dependent velocities for massless particles, 15:33322 (J;US)
MASURIUM
See TECHNETIUM
MATERIAL BALANCE
Application of near real time accountancy to nuclear material balance data, 15:32257 (R;DE)
MATERIAL UNACCOUNTED FOR
Application of near real time accountancy to nuclear material balance data, 15:32257 (R;DE)
MATERIALS
See also COMPOSITE MATERIALS
DIELECTRIC MATERIALS
DOPED MATERIALS
ENVIRONMENTAL MATERIALS
HAZARDOUS MATERIALS
ION EXCHANGE MATERIALS
LUNAR MATERIALS
POROUS MATERIALS
RADIOACTIVE MATERIALS
REACTOR MATERIALS
REINFORCED MATERIALS
SEMICONDUCTOR MATERIALS
THERMONUCLEAR REACTOR MATERIALS
TOXIC MATERIALS
High-Speed Microphotographic Laboratory, 15:33013 (BA;US)
Materials Fabrication Division/Precision Engineering Program Combined Bibliography (1970–1989), 15:32530 (R;US)
The Berkeley atomic resolution microscope: An update, 15:33012 (BA;US)
MATERIALS (ANTIFERROMAGNETIC)
See ANTIFERROMAGNETIC MATERIALS
MATERIALS (COMPOSITE)
See COMPOSITE MATERIALS
MATERIALS (DIELECTRIC)
See DIELECTRIC MATERIALS
MATERIALS (DOPED)
See DOPED MATERIALS
MATERIALS (ENVIRONMENTAL)
See ENVIRONMENTAL MATERIALS
MATERIALS (FERROMAGNETIC)
See FERROMAGNETIC MATERIALS
MATERIALS (LUNAR)
See LUNAR MATERIALS
MATERIALS (POROUS)
See POROUS MATERIALS
MATERIALS (REINFORCED)
See REINFORCED MATERIALS
MATERIALS (SEMICONDUCTOR)
See SEMICONDUCTOR MATERIALS
MATHEMATICAL MANIFOLDS
See also COMPLEX MANIFOLDS
On Einsteinian 4-submanifolds in E^6, 15:33669 (R;XA)
The symplectic structure of submanifolds of Kaehler manifolds of non-positive curvature, 15:33701 (R;XA)
MATTER
See also NUCLEAR MATTER
QUARK MATTER
Interaction of ionizing radiation with matter, 15:32830 (BA;US)
MBE
See MOLECULAR BEAM EPITAXY
MEASURING INSTRUMENTS
See also ANEMOMETERS
BOLOMETERS
CALORIMETERS

ELLIPSOMETERS
INTERFEROMETERS
LYSIMETERS
RADIATION DETECTORS
RADIOMETRIC GAGES
SPECTROMETERS
VELOCIMETERS

Method of fabricating an oxide-aluminum humidity sensor, 15:33002 (R;US)
Quality control and the use of reference materials in an environmental laboratory, 15:33011 (BA;US)
SDA/LARS™ final report: Development and verification of a learning and recognition system (LARStrademark) for seismic data analysis (SDA), 15:33001 (R;US)

MEASURING METHODS
Accuracy of wind measurements and international intercalibration of anemometers, 15:32304 (R;NL;In Dutch)

MELANOCYTES
See ANIMAL CELLS

MELTDOWN
Fission product release as a function of chemistry and fuel morphology, 15:32345 (R;US)

MEMBRANES
See also PHOTOSYNTHETIC MEMBRANES
Assessment of membrane gas separation applications to METC [Morgantown Energy Technology Center] supported techniques: Final report, 15:32049 (R;US)
Electrochemical characterization of bilayer lipid membrane-semiconductor junctions, 15:32763 (J;US)

MERCURY
Concentrations of metals in Norton Sound seawater samples and human hair samples, 1989, 15:33188 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 5. Primary precious metals and mercury, secondary precious metals, secondary silver, secondary mercury. Final report, 15:33158 (R;US)
Toxicological profile for mercury. Final report, 15:33242 (R;US)

MERCURY 192
Observation of superdeformation in ^{192}Hg, 15:33558 (J;US)

MERCURY COMPOUNDS
See also MERCURY TELLURIDES
The growth of high quality CdTe on GaAs by molecular beam epitaxy, 15:32754 (J;US)

MERCURY IODIDES
Photoluminescence spectroscopy of thin indium-tin-oxide contracts on mercuric iodide substrates, 15:32632 (BA;US)

MERCURY TELLURIDES
Band-gap narrowing in ordered and disordered semiconductor alloys, 15:32750 (J;US)

MESON FACTORIES
Plasma compensation effects with relativistic electron beams, 15:32917 (BA;US)

MESON RESONANCES
See MESONS

MESON-DEUTERON INTERACTIONS
See DEUTERIUM TARGET

MESON-NUCLEON INTERACTIONS
Consistent three-nucleon forces in the nuclear many-body problem, 15:33443 (R;FR)

MESONS
See also CHARMED MESONS
An experimental study of the A-dependence of J/psi photoproduction, 15:33527 (R;BR)
Observed supersymmetry in baryon and meson spectra with IBFM, the interacting boson fermion model, 15:33441 (R;BR)

MESSENGER-RNA
[Molecular characteristics of the lignin forming peroxidase]: Progress report, 15:33195 (R;US)

METABOLIC DISEASES
Gallium a unique anti-resorptive agent in bone: Preclinical studies on its mechanisms of action, 15:33212 (R;US)

METAGALAXY
See UNIVERSE

METAL INDUSTRY
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 5. Primary precious metals and mercury, secondary precious metals, secondary silver, secondary mercury. Final report, 15:33158 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point-source category, 15:33153 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 9. Primary and secondary titanium, primary zirconium and hafnium. Final report, 15:33161 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 1. General. Final report, 15:33154 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 10. Primary and secondary germanium and gallium, primary rare earth metals, secondary indium. Index. Final report, 15:33162 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 2. Bauxite refining, primary aluminum smelting, secondary aluminum smelting. Final report, 15:33155 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 6. Primary tungsten, secondary tungsten and cobalt, primary molybdenum and rhenium, secondary molybdenum and vanadium. Final report, 15:33159 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 7. Primary beryllium, primary nickel and cobalt, secondary nickel, secondary tin. Final report, 15:33160 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 4. Primary zinc, primary lead, secondary lead, primary antimony. Final report, 15:33157 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 3. Primary copper smelting, primary electrolytic copper refining, secondary copper, metallurgical acid plants. Final report, 15:33156 (R;US)
Health and safety guide for inorganic compounds and metals used in the fabrication of superconductive alloys, 15:33234 (R;US)
Utilization of the residual energy of integrated iron- and steelworks: Technical and economic limits, 15:32501 (R;GB)
Utilization of waste heat in sintering process, 15:32500 (R;GB)

METAL VAPOR LASERS
Measurement of ground state copper density using hook spectroscopy, 15:32888 (BA;US)

METALLURGICAL FLUX
Filler metal development for hastelloy alloy XR, 15:32546 (R;JP;In Japanese)

METALS
See also ACTINIDES
ALKALI METALS
ALKALINE EARTH METALS
ALUMINIUM
ANTIMONY
CADMIUM
GALLIUM
GERMANIUM
INDIUM
LEAD
LIQUID METALS
MERCURY
RARE EARTHS
REFRACTORY METALS
SCRAP METALS
TIN

TRANSITION ELEMENTS
ZINC
Corrosion prevention: Conversion coatings and coating processes. July 1971-January 1990 (A Bibliography from the US Patent data base). Report for July 1971-January 1990, 15:32555 (R;US)
Critical phenomena in nanoscale multilayer materials, 15:32565 (BA;US)
Determination of heavy metals on the Rock River through the analysis of sediments, 15:33145 (R;US)
Development of a new fluorometric detection test of sulfatoreducing bacteria type Desulfovibrio. Laboratory evaluation of chemical control of bacteria activity in biocorrosion, 15:32545 (R;FR;In French)
Encapsulation of mixed radioactive and hazardous waste contaminated incinerator ash in modified sulfur cement, 15:32199 (R;US)
Evidence that similar point defects cause 1/f noise and radiation-induced-hole trapping in metal-oxide-semiconductor transistors, 15:32749 (J;US)
Formation of excited hydrogen states in stimulated desorption from an alkali-promoted surface, 15:33637 (J;US)
Health and safety guide for inorganic compounds and metals used in the fabrication of superconductive alloys, 15:33234 (R;US)
Interfacial chemistry of metals on CdTe and ZnTe (110), 15:32757 (J;US)
Low-temperature epitaxial growth of thin metal films, 15:33650 (J;US)
Metals testing report: Metal content of environmental samples from Region 4, 15:33250 (R;US)
Multicomponent ultrafine microstructures, 15:32617 (B;US)
Toxicity bioassays: Water pollution effects on aquatic animals and plants. June 1986-February 1990 (A bibliography from the Selected Water Resources Abstracts data base). Report for June 1986-February 1990, 15:33183 (R;US)

METEORITES
Identification of solar nebula condensates in interplanetary dust particles and unequilibrated ordinary chondrites, 15:33306 (RA;US)

METHANE
Geologic evaluation of critical production parameters for coalbed methane resources. Part 1. San Juan Basin. Annual report, August 1988-July 1989, 15:32106 (R;US)
New directions for the catalytic conversion of methane. Annual report, January-December 1989, 15:32181 (R;US)
[Conversion of acetic acid to methane by thermophiles]: Progress report, May 15, 1985–May 15, 1990, 15:32267 (R;US)

METHANE HYDRATES
See GAS HYDRATES

METHANOL
Development of methanol reformer, 15:32264 (R;JP)
Evaluation of mixed alcohol production processes and catalysts, 15:32273 (R;US)

METHANOL FUELS
A summary of prospects for methanol vehicles in the United States, 15:32525 (R;US)

METHYL ALCOHOL
See METHANOL

METHYL PHENOLS
See CRESOLS

METHYL RADICALS
Study of the recombination reaction $CH_3+Ch_3 \rightarrow C_2H_6$: Theory, 15:32274 (BA;US)

METHYL-FUEL
See ALCOHOLS
METHANOL

METHYLBENZENE
See TOLUENE

METHYLENE CHLORIDE
Health-hazard evaluation report HETA 87-075-1988, American Cyanamid, Wallingford, Connecticut, 15:33074 (R;US)

METROPOLITAN AREAS
See URBAN AREAS

MHD GENERATOR CDIF
Component Development and Integration Facility quarterly technical progress report, January 1–March 31, 1990, 15:32474 (R;US)

MHD GENERATORS
Comparative three-dimensional flow analysis of MHD generators and seawater thrusters, 15:32473 (R;US)

MICHELSON INTERFEROMETER
Interferometric second-harmonic-generation autocorrelator for characterizing femtosecond pulses, 15:32993 (R;US)

MICHIGAN
Superfund Record of Decision (EPA Region 5): Ionia City Landfill, Ionia, Michigan (First remedial action, September 1989), 15:33147 (R;US)

MICROBIAL FLORA
See MICROORGANISMS

MICROCHANNEL ELECTRON MULTIPLIERS
Multiframe x-ray images from a single meander stripline coated on a microchannel plate, 15:32979 (R;US)

MICROEMULSIONS
Interdroplet attractive forces in AOT water-in-oil microemulsions formed in subcritical and supercritical solvents, 15:32815 (J;US)

MICROFLORA
See MICROORGANISMS

MICROORGANISMS
See also BACTERIA
Methods to measure the influence of genetically engineered bacteria on ecological processes in soil, 15:32281 (R;US)

MICROPROCESSORS
SEU characterization and design dependence of the SA3300 microprocessor, 15:33853 (R;US)

MICROWAVE AMPLIFIERS
Microwave generation for magnetic fusion energy applications, Task B: Progress report, September 15, 1989–September 14, 1990, 15:33808 (R;US)
Microwave generation for magnetic fusion energy applications, Task C: Progress report, September 15, 1989–September 14, 1990, 15:33809 (R;US)

MICROWAVE EQUIPMENT
See also MICROWAVE AMPLIFIERS
An algorithm for using a slide-screw tuner as a computer-controlled impedance, 15:32883 (R;US)

MICROWAVE RADIATION
Microwave processing of silicon nitride, 15:32605 (R;US)

MIGRATION (RADIONUCLIDE)
See RADIONUCLIDE MIGRATION

MILITARY EQUIPMENT
Reserve force: DOD guidance needed on assigning roles to reserve under the total policy, 15:32469 (R;US)

MILITARY FACILITIES
First-phase study design for the US Navy Radon Assessment and Mitigation Program (NAVRAMP), 15:32481 (R;US)
Hazardous waste: Attention to DOD inventories of hazardous materials needed, 15:32506 (R;US)
The AFLC ECAMP [Environmental Compliance Assessment and Management Program] experience: How it was done and lessons learned, 15:32442 (R;US)

MILITARY PERSONNEL
Comparison of serum levels of 2,3,7,8-tetrachlorodibenzo-p-dioxin with indirect estimates of Agent Orange exposure among Vietnam veterans. Final report, 15:33235 (R;US)

MILK
Hanford Environmental Dose Reconstruction Project: Monthly report, 15:33102 (R;US)

MILKY WAY
The age of the galactic disk, 15:33299 (R;US)

MILL TAILINGS
Feasibility testing of in situ vitrification of uranium-contaminated soils, 15:32244 (BA;US)
Long-term stability of solid standards for radiochemical analysis, 15:32785 (R;US)

MINE-MOUTH GENERATING PLANTS
See COAL MINES
FOSSIL-FUEL POWER PLANTS
MINERAL OIL
See LUBRICANTS
MISGURNUS
See FISHES
MISSILES
See also CRUISE MISSILES
Exchange ratios for singlet boost-phase defenders, 15:33040 (R;US)
MIXED CARBIDE FUELS
HTGR reactor fuel, 15:32325 (R;CS;In Czech)
MIXED OXIDE FUELS
HTGR reactor fuel, 15:32325 (R;CS;In Czech)
MIXING
Turbulence modeling in the SHALE code, 15:33386 (R;US)
MIXTURES
Renormalized equations for linear transport in stochastic media, 15:33393 (J;US)
MM-0011
See NICKEL BASE ALLOYS
MODELS (COSMOLOGICAL)
See COSMOLOGICAL MODELS
MODELS (NUCLEAR)
See NUCLEAR MODELS
MODELS (PLASMA)
See PLASMA SIMULATION
MODELS (STAR)
See STAR MODELS
MODELS (STRUCTURAL)
See STRUCTURAL MODELS
MODULAR CONSTRUCTION
See MODULAR STRUCTURES
MODULAR STRUCTURES
A hierarchical approach to large space structure control, 15:32497 (R;US)
MOESSBAUER EFFECT
Local oxygen configurations relative to $F_e$probe ions in $HoBa_2{}^{Cu}{}_{0.95}{}^{Fe}{}_{0.053}{}^{O}{}_{7-x}$, 15:32663 (BA;US)
MOLDAVITES
See TEKTITES
MOLECULAR BEAM EPITAXY
Molecular beam epitaxy regrowth by use of ammonium sulfide chemical treatments, 15:32753 (J;US)
MOLECULAR FLUORESCENCE SPECTROSCOPY
See FLUORESCENCE SPECTROSCOPY
MOLECULAR ORBITAL MODEL
See MOLECULES
MOLECULAR STRUCTURE
WIPP/SRL [Waste Isolation Pilot Plant/Savannah River Laboratory] in-situ tests: Compositional correlations of MIIT [Materials Interface Interactions Test] waste glasses, 15:32213 (R;US)
MOLECULES
See also POLYATOMIC MOLECULES
Selection rules in resonance electron scattering from adsorbed molecules, 15:33649 (J;US)
Ultrafast time-resolved fluorescence spectroscopy, 15:32801 (J;US)
MOLTEN CARBONATE FUEL CELLS
Effects of coal-derived trace species on the performance of molten carbonate fuel cells: Technical progress report No. 15 (annual progress and interim project evaluation), August 22, 1988–August 21, 1990, 15:32476 (R;US)
MOLYBDENUM
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 6. Primary tungsten, secondary tungsten and cobalt, primary molybdenum and rhenium, secondary molybdenum and vanadium. Final report, 15:33159 (R;US)
Minerals yearbook, 1988. Molybdenum, 15:32458 (R;US)
Molycorp Guadalupe Mountain tailings disposal facility. Final report, 15:33167 (R;US)
MOLYBDENUM 100
Monopole strength and shape coexistence in the $A \cong 100$ mass region, 15:33544 (J;US)
MOLYBDENUM IONS
Spectrum and energy levels of six-times-ionized molybdenum (Mo VII), 15:33345 (J;US)
MOLYBDENUM SILICIDES
Proximity effect in superconducting bilayers and multilayers, 15:32596 (J;US)
MOLYBDENUM SULFIDES
Evaluation of mixed alcohol production processes and catalysts, 15:32273 (R;US)
MONAZITES
Bubble attachment time measurements for selected rare-earth phosphate minerals in oleate solutions, 15:32798 (BA;US)
MONITORING
A decision-analysis process to support verification technology research and development, 15:32528 (R;US)
MONITORING NETWORK
See MONITORING
MONITORS (AIR POLLUTION)
See AIR POLLUTION MONITORS
MONITORS (REACTOR)
See REACTOR CONTROL SYSTEMS
MONOCHLOROETHYLENE
See VINYL CHLORIDE
MONOCLONAL ANTIBODIES
Expert systems for flow cytometry data analysis: A preliminary report, 15:33214 (R;US)
MOON
Transportation and operations aspects of space energy systems, 15:32263 (RA;US)
MOS TRANSISTORS
1/f noise in irradiated MOS devices, 15:32987 (R;US)
Field dependence of interface trap buildup in Si-gate MOS devices, 15:32882 (R;US)
Predicting switched-bias response from steady-state irradiations, 15:33042 (R;US)
MT-1 TOKAMAK
Impurity flux collection at the plasma edge of the tokamak MT-1, 15:33783 (R;HU)
MUF
See MATERIAL UNACCOUNTED FOR
MULTI-CENTER SHELL MODEL
Definition of a multicentral bond index, 15:33326 (R;BR)
MULTICHARGED IONS
Sources of multiply charged ions for heavy-ion fusion, 15:33801 (J;US)
Spectrum and energy levels of six-times-ionized molybdenum (Mo VII), 15:33345 (J;US)
MULTIPROCESSING
See PARALLEL PROCESSING
MULTIPROCESSORS
See ARRAY PROCESSORS
MUON PAIRS
Lattice calculation of muon-pair production with capture in relativistic heavy-ion collisions, 15:33593 (J;US)
MUON-CATALYZED FUSION
Muonic molecular structure, μ-sticking probability and fusion rates for muon catalyzed fusion: Final technical report, 15:33720 (R;US)
MUONIC ATOMS
Two-body fragmentation channels of three-body systems, 15:33367 (J;US)

N

N-TYPE CONDUCTORS
Nitrogen doping of ZnO prepared by organometallic chemical vapor deposition, 15:32642 (BA;US)
NAPAP
National Acid Precipitation Assessment Program (NAPAP) county-level alkaline emission estimates for unpaved roads.

Dust Devils and wind erosion, 1985 (for microcomputers). Data file, 15:33094 (R;US)

NAPHTHA
Jet fuels potential of liquid by-products from the Great Plains Gasification Project, 15:32048 (R;US)
Production of jet fuels from coal derived liquids: Volume 6, Preliminary analysis of upgrading alternatives for the Great Plains liquid by-product streams: Interim report, March 1987–February 1988, 15:32058 (R;US)

NAPHTHENES
See CYCLOALKANES

NASA
Nuclear power applications of NASA control and diagnostics technology: Volume 1, Project results: Final report, 15:32341 (R;US)
Nuclear power applications of NASA control and diagnostics technology: Volume 2, Technical report: Final report, 15:32342 (R;US)

NATIONAL ACID PRECIPITATION ASSESSMENT PROGRAM
See NAPAP

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
See NASA

NATIONAL DEFENSE
See also BALLISTIC MISSILE DEFENSE
Defense Nuclear Agency (DNA). Directive, 15:33015 (R;US)

NATIONAL ENVIRONMENTAL POLICY ACT
Hanford Site National Environmental Policy Act (NEPA) characterization: Revision 2, 15:33101 (R;US)

NATIONAL REACTOR TESTING STATION
See IDAHO NATIONAL ENGINEERING LABORATORY

NATURAL GAS
Analyses of natural gases, 1917-1989. Data file, 15:32182 (R;US)
Development of a catalytic infrared cooking gas burner, 15:32178 (R;US)
Drinking water: Safeguards are not preventing contamination from injected oil and gas wastes, 15:32153 (R;US)
Natural gas requirements for electricity generation through 2000: Can the natural gas industry meet them?: Volume 1: Final report, 15:32174 (R;US)
Natural gas requirements for electricity generation through 2000: Can the natural gas industry meet them?: Volume 2, Appendix B, Gas supply issues: Final report, 15:32175 (R;US)
Natural gas transport by plastic pipes. January 1970-January 1990 (A Bibliography from the COMPENDEX data base). Report for January 1970-January 1990, 15:32180 (R;US)
Prospects for alternatives to liquid-petroleum-vehicle fuels. Summary of the annual GRI (Gas Research Institute) energy seminar (10th) for the GRI board of directors and advisory council. Held in Vail, Colorado on August 7-9, 1989. Topical report, 15:32526 (R;US)
Purchase of natural gas by the Albuquerque Operations Office, 15:32173 (R;US)
Technology choice in a least-cost expansion analysis framework: The impact of gas prices, planning horizon, and system characteristics, 15:32318 (R;US)

NATURAL GAS DEPOSITS
Geologic evaluation of critical production parameters for coalbed methane resources. Part 1. San Juan Basin. Annual report, August 1988-July 1989, 15:32106 (R;US)
Physicochemical properties of methane storage and transport in Devonian shale. Annual technical report, June 1988-May 1989, 15:32171 (R;US)

NATURAL GAS DISTRIBUTION SYSTEMS
The natural gas pipeline servicing Los Alamos National Laboratory, 15:32179 (R;US)

NATURAL GAS GATHERING SYSTEMS
See NATURAL GAS DISTRIBUTION SYSTEMS

NATURAL GAS INDUSTRY
Chemical Process Research Department R and D status report. December 1989, 15:32177 (R;US)
Prospects for alternatives to liquid-petroleum-vehicle fuels. Summary of the annual GRI (Gas Research Institute) energy seminar (10th) for the GRI board of directors and advisory council. Held in Vail, Colorado on August 7-9, 1989. Topical report, 15:32526 (R;US)

NATURAL LIGHTING
See DAYLIGHTING

NAVAL PETROLEUM RESERVE
Endangered species program, Naval Petroleum Reserves in California: Annual report FY89, 15:32152 (R;US)

NAVAL REACTORS
See SHIP PROPULSION REACTORS

NEA
General report of the Insurance Study Committee, 15:32367 (R;IT)

NEGATONS
See ELECTRONS

NEGATRONS
See ELECTRONS

NEODYMIUM
Measurements of heating and energy storage in diode-pumped Nd YAG, 15:33788 (J;US)

NEODYMIUM LASERS
KD*P frequency doubler for high average power applications, 15:32885 (R;US)
Low cost active–active oscillator utilizing loss feedback control, 15:32903 (J;US)

NEODYMIUM OXIDES
Effects of zinc substitution on the electron superconductor $Nd_{1.85}Ce_{0.15}CuO_{4-\delta}$, 15:32692 (J;US)
Magnetic order of the Cu planes and chains in $RBa_2Cu_3O_{6+x}$, 15:32685 (J;US)
Magnetic ordering of Nd in $(Nd,Ce)_2CuO_4$, 15:32680 (J;US)
Magnetism, specific heat, and pressure-dependent reistivity of the electron-doped compounds LnMCuO(Ln = Pr,Nd,Sm,Eu,Gd:M = Ce,Th), 15:32641 (BA;US)
Polarized resonance photoemission for Nd_2CuO_4, 15:32694 (J;US)
Structural and superconducting properties of oxygen-deficient $NdBa_2Cu_3O_{7-\delta}$, 15:32688 (J;US)
Superconductivity and magnetic scattering in the $Nd_{2-z}Ce_xCuO_{4-gd}$, 15:32618 (BA;US)
Upper critical field of a $Sm_{1.85}Ce_{0.15}CuO_{4-y}$ single crystal: Interaction between superconductivity and antiferromagnetic order in copper oxides, 15:32670 (J;US)

NEON
CW ultraviolet and visible laser action from ionized silver in an electron beam generated plasma, 15:33790 (J;US)

NEOPLASMS
See also CARCINOMAS
LEUKEMIA
SARCOMAS
NIOSH (National Institute for Occupational Safety and Health) Testimony on the safety of nuclear facility workers by P. J. Bierbaum on April 22, 1985, 15:32255 (R;US)
NIOSH (National Institute for Occupational Safety and Health) testimony on asbestos by R. A. Lemen on March 21, 1984, 15:33237 (R;US)
PBF/BNCT [Power Burst Facility/Boron Neutron Capture Therapy] Program for Cancer Treatment: Monthly bulletin, Volume 4, No. 3, 15:33222 (R;US)

NEPA
See NATIONAL ENVIRONMENTAL POLICY ACT

NEPTUNE PLANET
Neptune's Triton: A moon rich in dry ice and arbon, 15:33310 (R;US)

NETWORKS (COMPUTER)
See COMPUTER NETWORKS

NEURAL NETWORKS
Accelerator diagnosis and control by Neural Nets, 15:32949 (BA;US)

NEUTRAL BEAM SOURCES
An autoneutralizing neutral molecular beam gun, 15:33362 (J;US)

NEUTRINOS
Double-beta decay, 15:33536 (J;US)
Radiative neutrino decay in a medium, 15:33459 (J;US)

Search for long-lived massive neutrinos in Z decays, 15:33415 (J;US)

NEUTRON CAPTURE
See NEUTRON REACTIONS

NEUTRON DETECTORS
See also BF3 COUNTERS
Altitude-velocity envelope for a moving neutron detector, 15:32980 (R;US)

NEUTRON DOSIMETRY
Neutron exposure parameters for the metallurgical test specimens in the sixth heavy-section steel irradiation series, 15:32338 (R;US)

NEUTRON ECONOMY
See NEUTRON FLUX

NEUTRON FLUX
Determination of neutron flux densities in WWR-S reactor core, 15:32355 (R;CS;In Czech)

NEUTRON FLUX DENSITY
See NEUTRON FLUX

NEUTRON GUIDES
Monte Carlo modelling for neutron guide losses, 15:32353 (R;HU)

NEUTRON MATTER
See NUCLEAR MATTER

NEUTRON MONITORS
Subcriticality monitering method based on the count-rate ratio, 15:32851 (RA;JP;In Japanese)

NEUTRON REACTIONS
Multiconfiguration resonating-group theory of ^{8}Li, 15:33579 (J;US)
Reply to "Absence of parity effects in preequilibrium γ emission", 15:33588 (J;US)

NEUTRONS
See also FISSION NEUTRONS
Comments on "Neutron-proton mass difference in the chiral solitonic bag model", 15:33584 (J;US)
Interpretation of the neutron electric dipole moment: Possible relationship to $|\epsilon'|$, 15:33456 (J;US)
Neutral-Higgs-boson contribution to the electric dipole moment of the neutron, 15:33464 (J;US)
Precise extractions of the x and Q^2 dependence of $R \equiv \sigma_L/\sigma_T$, F_{2p}, F_{2d}, and $F_{2n}/_{2p}$ from a combined analysis of SLAC [Stanford Linear Accelerator Center] deep inelastic electron scattering experiments, 15:33433 (R;US)

NEVADA
Geologic map of the surficial deposits of the Yucca Flat area, Nye County, Nevada, 15:33278 (R;US)

NEVADA TEST SITE
Electric logging and electrical properties of rocks in Rainier Mesa area, Nevada Test Site, Nevada, 15:32717 (R;US)
Radiological effluents released from announced US continental tests, 1961 through 1988, 15:33035 (R;US)

NEW JERSEY
An aerial radiological survey of the Evans Area, US Army Communications-Electronics Command, Fort Monmouth, New Jersey: Date of survey, November 1988, 15:33055 (R;US)
Health assessment for Beachwood Borough and Berkeley Township National Priorities List (NPL) Site, Ocean County, New Jersey, Region 2. CERCLIS No. NJD980654123. Final report, 15:33142 (R;US)
Superfund Record of Decision (EPA Region 2): FAA (Federal Aviation Administration) Technical Center, Atlantic County, New Jersey (First remedial action), September 1989, 15:32156 (R;US)

NEW MEXICO
Geologic evaluation of critical production parameters for coalbed methane resources. Part 1. San Juan Basin. Annual report, August 1988-July 1989, 15:32106 (R;US)

NEW YORK
The environmental compliance process at New York FUSRAP [Formerly Utilized Sites Remedial Action Program] sites, 15:32253 (R;US)

NEWTON MECHANICS
See CLASSICAL MECHANICS

NEWTON METHOD
The location of zeros using generalizations of Newton's method, 15:33698 (R;XA)

NICKEL
Cascade collapse in copper and nickel, 15:32540 (R;US)
Concentrations of metals in Norton Sound seawater samples and human hair samples, 1989, 15:33188 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 7. Primary beryllium, primary nickel and cobalt, secondary nickel, secondary tin. Final report, 15:33160 (R;US)
Encoding of the Burgess metal electrical resistivity model into SESAME format and its adaptation to the metal nickel, 15:32548 (R;US)
Fourier-transform and continuous-wave EPR studies of nickel in synthetic diamond: Site and spin multiplicity, 15:32775 (J;US)
Health-hazard evaluation report HETA 87-075-1988, American Cyanamid, Wallingford, Connecticut, 15:33074 (R;US)
Moving species during ion mixing in Ge_xSi_{1-x}/metal systems, 15:32760 (J;US)
National Performance Audit Program: Acid rain audits, 1988, 15:33082 (R;US)
Precipitation of Ar, Kr and Xe in Ni at room temperature, 15:32730 (BA;US)
Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the Salton Sea Area, California, 1986-87. Water-Resources investigation, 15:33164 (R;US)
X-ray diffraction analysis of Au/Ni multilayers, 15:32570 (BA;US)
X-ray diffraction study of the Ni(111)5°[1$\bar{1}$0] vicinal surface, 15:32588 (J;US)

NICKEL ALLOYS
See also HAVAR
NICKEL BASE ALLOYS
Atomic and electronic structure of the NiAl(111) surface, 15:32597 (J;US)
Au-Ge-Ni-Ti ohmic contacts on gallium arsenide, 15:32537 (R;US)
Role of melting temperature on the properties of displacement cascades, 15:32541 (R;US)
Some thermodynamic propeties of NiAl calculated by molecular dynamics simulations, 15:32563 (BA;US)
Weldability of nickel aluminides, 15:32542 (R;US)

NICKEL BASE ALLOYS
See also HASTELLOYS
INCONEL ALLOYS
Effect of aluminum level on boron clustering in Ni_3Al, 15:32560 (BA;US)
Effect of preoxidation and grain size in ductility of a boron-doped Ni_3Al at elevated temperatures, 15:32571 (BA;US)
Reinforcement/matrix interaction in SiC fiber-reinforced Ni_3Al matrix composites, 15:32582 (BA;US)
Stacking fault energies, crystal elasticity and their relation to the mechanical properties of $L1_2$-ordered alloys, 15:32561 (BA;US)
Surface energy anisotropy of diffusion-induced Ni_3Al crystals, 15:32567 (BA;US)
The development of alloys based on Ni_3Si, 15:32578 (BA;US)

NICKEL IONS
Experimental determination of a species-dependent effect in the transverse emittances of sputter-generated negative-ion beams, 15:33640 (J;US)

NICKEL OXIDES
$La_2CuO_{4+\delta d}$and $La_2NiO_{4+\delta d}$: Phase separation resulting from excess oxygen defects, 15:32619 (BA;US)
Orbital polarization and the insulating gap in the transition-metal oxides, 15:32673 (J;US)

NICKEL-CHROMIUM STEELS
Prediction of the brittle-ductile transition temperature shift, from irradiation experiments obtained in France, 15:32533 (R;FR;In French)

NICOTINE
Rapid determination of nicotine in urine by direct thermal desorption ion trap mass spectrometry, 15:32782 (R;US)

NIGERIA
The effects of rainfall energy on soil erosion in Southern Nigeria, 15:33128 (R;XA)
NIOBATES
Characterization of $KNbO_3$ thin films deposited by ion beam sputtering using a computer-controlled rotating target holder, 15:32635 (BA;US)
Ion implantation and ion beam analysis of lithium niobate, 15:32657 (BA;US)
NIOBIUM
Phases and microstructures of carbon-implanted niobium, 15:32645 (BA;US)
The energetics associated with the formation of interfaces, multilayers and adlayers, 15:32812 (BA;US)
NIOBIUM 93
Probability of ternary fission of ^{93}Nb and^{nat} Ag nuclei induced by 0.8-1.8 GeV photons, 15:33539 (R;BR)
NIOBIUM 93 TARGET
Observation of double isovector giant dipole resonances from pion double charge exchange, 15:33535 (J;US)
NIOBIUM ALLOYS
Fabrication of Rutherford-type superconducting cables for construction of dipole magnets, 15:32897 (BA;US)
Phase stability of Ni_3Al_3 under electron irradiation, 15:32580 (BA;US)
NIOBIUM COMPOUNDS
See also NIOBATES
NIOBIUM OXIDES
NIOBIUM SELENIDES
High-temperature defect structure of Nb-doped $LaCrO_3$, 15:32669 (J;US)
NIOBIUM OXIDES
Calculation of ion channeling directions in low symmetry optical materials, 15:32643 (BA;US)
Ion implantation of Ti into $LiNbO_3$: Fabrication of waveguides and simple modulators, 15:32995 (BA;US)
NIOBIUM SELENIDES
NMR studies of $NbSe_3$: Electronic structures, static charge-density-wave measurements, and observations of the moving charge-density wave, 15:32766 (J;US)
NITRATES
See also ALUMINIUM NITRATES
PEROXYACETYL NITRATE
SODIUM NITRATES
YTTRIUM NITRATES
Evaluation of the role of ozone, acid deposition, and other airborne pollutants in the forests of eastern North America. Forest Service general technical report, 15:33085 (R;US)
Urban aerosol transformation and transport modeling. Report for October 1985-October 1988, 15:33091 (R;US)
NITRO COMPOUNDS
See also NITROMETHANE
Burning mechanism and regression rate of RX-35-AU and RX-35-AV as a function of HMX particle size measured by the hybrid closed bomb-strand burner, 15:33031 (R;US)
NITROGEN
Indices governing optical self-focusing and self-induced changes in the state of polarization in N_2, O_2, H_2, and Ar gases, 15:32765 (J;US)
Production of N_2^+ first negative emission by impact of 1-MeV H^0, H^+, and H^- on N_2, 15:33378 (J;US)
NITROGEN COMPOUNDS
See also HYDRAZINE
NITRATES
NITROGEN OXIDES
The importance of thermodynamics to the modeling of nitrogen combustion chemistry, 15:32838 (J;US)
NITROGEN DIOXIDE
Biological effects of combined exposure to coal fly ash and nitrogen dioxide, 15:32122 (R;JP;In Japanese)
Diesels in the occupational environment: An environmental perspective, 15:33073 (R;US)
NITROGEN IONS
Production of atomic nitrogen ion beams, 15:33347 (J;US)
NITROGEN NITRIDES
See NITROGEN
NITROGEN OXIDES
See also NITROGEN DIOXIDE
NITROUS OXIDE
Beneficiated fine-particle coal as a source of energy in small-scale applications, 15:32115 (RA;US)
Emissions involved in acidic deposition processes: Methodology and results, 15:33048 (R;US)
Hanford Waste Vitrification Plant Clean Air Act permit application, 15:32211 (R;US)
Simultaneous NO_x/SO_2 removal with dry sorbent injection, 15:32314 (RA;US)
NITROMETHANE
Destruction of propellant components in supercritical water, 15:32806 (R;US)
NITROUS OXIDE
Health-hazard evaluation report HETA 89-007-1983, St. Thomas More Hospital, Canyon City, Colorado, 15:33236 (R;US)
Nitrous oxide emissions from Danish power plants, 15:32096 (R;DK)
NOBLE GASES
See RARE GASES
NOISE
Industrial-hygiene walk-through report, Cyprus Industrial Minerals Company, Bay Street Mill, Los Angeles, California, 15:33240 (R;US)
NONAXIAL NUCLEI
See DEFORMED NUCLEI
NONDESTRUCTIVE ANALYSIS
See also X-RAY EMISSION ANALYSIS
On-line monitor for metallic wear products. Phase 1. Final report, 15:32260 (R;US)
NONLUMINOUS MATTER
Proceedings of workshop on dark matter and the structure of the universe, 15:33315 (R;JP)
NORTH AMERICA
See also CANADA
Multi-dimensional aspects of recent climate change in North America: Progress report, August 15, 1989–April 1, 1990, 15:33054 (R;US)
NORTH CAROLINA
Evaluation of detention-basin performance in the Piedmont region of North Carolina, 15:33180 (R;US)
Modeling organic-contaminant sorption impacts on aquifer restoration, 15:33169 (R;US)
Paleotectonic significance of the quartzite of the Sauratown Mountains window, North Carolina, 15:33282 (J;US)
NORTH DAKOTA
Coupled biological downflow fluid bed reactor treatment of synfuels wastewater, 15:33189 (BA;US)
NORTHERN IRELAND
See UNITED KINGDOM
NOVAE
Recent progress in understanding the eruptions of classical novae, 15:33300 (R;US)
NRTS
See IDAHO NATIONAL ENGINEERING LABORATORY
NUCLEAR ATTACKS
See NUCLEAR WEAPONS
NUCLEAR CONTROVERSY
See HUMAN POPULATIONS
NUCLEAR DATA COLLECTIONS
[NEANDC/NEACRP Task Force on Nuclear Data Evaluation Cooperation]: Foreign trip report, April 28, 1990–May 2, 1990, 15:33529 (R;US)
NUCLEAR ENERGY AGENCY
See NEA
NUCLEAR EXPLOSION DETECTION
SDA/LARS™ final report: Development and verification of a learning and recognition system (LARStrademark) for seismic data analysis (SDA), 15:33001 (R;US)

NUCLEAR EXPLOSIONS
A parametric investigation of electrical effects on aerosol scavenging by droplets over large fires, 15:33108 (R;US)

NUCLEAR FACILITIES
See also FUEL REPROCESSING PLANTS
NUCLEAR POWER PLANTS
RADIOACTIVE WASTE FACILITIES
SURPLUS NUCLEAR FACILITIES
Sandia National Laboratories data engineering for DOE production agencies, 15:33863 (R;US)
Wind tunnel tests on the evaluation of interferences due to buildings on the propagation of radioactive materials after release from nuclear facilities. Report and annex, 15:33046 (R;DE;In German)

NUCLEAR FRAGMENTATION
Quasifree fragmentation of radioactive projectiles: Extended Serber model, 15:33592 (J;US)

NUCLEAR FUEL ELEMENTS
See FUEL ELEMENTS

NUCLEAR FUELS
See also MIXED CARBIDE FUELS
SPENT FUELS
Criticality experiments with neutron flux traps containing voids, 15:32198 (R;US)

NUCLEAR INDUSTRY
Energy management: DOE has not shown systems contracting to be in government's best interest, 15:32464 (R;US)
Nuclear power industry: - activity discharge, - occupational exposures. Fourth quarter of 1988, 15:33606 (R;SE;In Swedish)

NUCLEAR MATERIALS MANAGEMENT
Applications of gamma-ray spectrometry in the quantitative nondestructive assay of special nuclear materials, 15:32258 (R;US)

NUCLEAR MATTER
Fluid-dynamics of the nuclear surface Fermi-layer, 15:33576 (R;HU)
Physics of the pion liquid, 15:33562 (R;US)

NUCLEAR MODELS
See also COLLECTIVE MODEL
Diabatic orbitals in nuclear structure, 15:33578 (R;SE)

NUCLEAR PHYSICS
Report of the Expert Committee 'Intermediate-Energy Physics' 1986-1988/89, 15:33400 (R;DE;In German)
Supplement to the report of the Expert Committee 'Intermediate-Energy Physics' 1986-1988/89, 15:33401 (R;DE;In German)
Supplement to the report of the Expert Committee 'Nuclear Physics and Heavy-Ion Research' 1986-1988/89, 15:33528 (R;DE;In German)

NUCLEAR POWER
The case for coal: Evidence by the Coalfield Communities Campaign to the Hinkley Point 'C' nuclear power station inquiry, 15:32329 (R;GB)

NUCLEAR POWER PLANTS
Instrument air system - Aging impact on system availability, 15:32412 (RA;US)

Accidents
Responding to emergencies: How organization and management make a difference, 15:32403 (RA;US)

Auxiliary Water Systems
Aging assessment of auxiliary feedwater systems, 15:32411 (RA;US)

Computerized Control Systems
Nuclear power applications of NASA control and diagnostics technology: Volume 2, Technical report: Final report, 15:32342 (R;US)

Containment Systems
Proving Test on the Reliability for Reactor Containment Vessel, 15:32388 (RA;US)
Seismic uplift of nuclear containments, 15:32386 (RA;US)
The influence of data collection rate, containment size and data smoothing on containment Integrated Leak Rate Tests, 15:32387 (RA;US)

Control Rooms
Human factors survey of advanced instrumentation and controls, 15:32409 (RA;US)
The effects of local control station design variation on plant risk, 15:32410 (RA;US)

Emergency Plans
Responding to emergencies: How organization and management make a difference, 15:32403 (RA;US)

Engineered Safety Systems
CSAU (code scaling, applicability and uncertainty), a tool to prioritize advanced reactor research, 15:32360 (R;US)

Environmental Impacts
Examination of the impact of radioactive liquid effluent releases from the Rancho Seco Nuclear Power Plant, 15:33190 (J;US)

Inspection
The use of NPAR [Nuclear Plant Aging Research] results in plant inspection activities, 15:32413 (RA;US)

Maintenance
The development and evaluation of programmatic performance indicators associated with maintenance at nuclear power plants: Appendices: Volume 2, 15:32421 (R;US)
The development and evaluation of programmatic performance indicators associated with maintenance at nuclear power plants: Main report: Volume 1, 15:32420 (R;US)

Reactor Components
Guidelines for the procurement and receipt of items for nuclear power plants (NCIG-15): Final report, 15:32335 (R;US)
Mechanical damage experience in major light water reactor systems, 15:32364 (R;US)
Ranking significant phenomena in physical systems, 15:32358 (R;US)

Reactor Control Systems
Human factors survey of advanced instrumentation and controls, 15:32409 (RA;US)
Nuclear power applications of NASA control and diagnostics technology: Volume 1, Project results: Final report, 15:32341 (R;US)

Reactor Cooling Systems
Assessment of TRAC-PF1/MOD1 Version 14.3 using separate effects critical flow and blowdown experiments: Volume 2, Figures, 15:32424 (R;US)
Assessment of TRAC-PF1/MOD1 version 14.3 using separate effects critical flow and blowdown experiments: Volume 1, Test and tables, 15:32423 (R;US)

Reactor Monitoring Systems
Nuclear power applications of NASA control and diagnostics technology: Volume 1, Project results: Final report, 15:32341 (R;US)
Nuclear power applications of NASA control and diagnostics technology: Volume 2, Technical report: Final report, 15:32342 (R;US)
Nuclear power applications of NASA control and diagnostics technology: Volume 3, Users manual: Final report, 15:32343 (R;US)

Reactor Safety
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Ranking significant phenomena in physical systems, 15:32358 (R;US)

Reliability
Nuclear Computerized Library for Assessing Reactor Reliability (NUCLARR): Summary description: Volume 1, Revision 1, 15:32416 (R;US)

Risk Assessment
PARTITION: A program for defining the source term/consequence analysis interface in the NUREG–1150 probabilistic risk assessments: User's guide, 15:32417 (R;US)
PRAMIS: Probability Risk Assessment Model Integration System: User's guide, 15:32418 (R;US)

Steam Generators
Proceedings: Primary water stress corrosion cracking: 1989 EPRI remedial measures workshop, 15:32336 (R;US)
NUCLEAR POWER STATIONS
See NUCLEAR POWER PLANTS
NUCLEAR REACTORS
See REACTORS
NUCLEAR SAFETY
See RADIATION PROTECTION
NUCLEAR STRUCTURE
Integrodifferential equation approach. Pt. 2. Triton and α-particle wave functions. Graphical plots, 15:33563 (R;DE)
NUCLEAR WASTES
See RADIOACTIVE WASTES
NUCLEAR WEAPON TESTS
See NUCLEAR EXPLOSIONS
NUCLEAR WEAPONS
Counterintelligence and operations security-support program for the Defense Nuclear Agency. Directive, 15:33020 (R;US)
DOE requirements for the next generation controller, 15:33038 (R;US)
Nuclear Weapon Personnel-Reliability Program. Directive, 15:33019 (R;US)
NUCLEON-NUCLEON INTERACTIONS
The nucleon-nucleon interaction in the presence of the electromagnetic field: Nucleon-nucleon bremsstrahlung, 15:33451 (R;US)
NUCLEON-NUCLEON POTENTIAL
See also SKYRME POTENTIAL
The pion in the deuteron, 15:33573 (R;FR)
NUCLEONS
See also NEUTRONS
PROTONS
Flavor-mixing structure functions in the Nambu–Jona-Lasinio model, 15:33468 (J;US)
Nucleon and isobar properties in a relativistic Hartree-Fock calculation with vector Richardson potential and various radial forms for scalar mass terms, 15:33569 (R;BR)
NUCLEOSIDES
Characterization of alkylated nucleosides by laser ionization Fourier transform mass spectrometry, 15:33199 (BA;US)
NUMERICAL DATA
See also COMPILED DATA
Wind turbine wake interference. A validation study. Vol. 2: Measurement results, 15:32303 (R;DK)

O

OAK RIDGE GASEOUS DIFFUSION PLANT
See ORGDP
OAK RIDGE NATIONAL LABORATORY
See ORNL
OBESITY
See METABOLIC DISEASES
OBSIDIANITES
See TEKTITES
OCEANS
See SEAS
OCTANE
Evaluation of mixed alcohol production processes and catalysts, 15:32273 (R;US)
OFF-GAS SYSTEMS
Offgas system particulate cleaning test and evaluation for the Process Experimental Pilot Plant, 15:32216 (R;US)
OFFICE BUILDINGS
NIOSH (National Institute for Occupational Safety and Health) testimony on indoor air quality by J. D. Millar on May 26, 1989, 15:33076 (R;US)
NIOSH (National Institute for Occupational Safety and Health) testimony on indoor air quality by J. Melius on August 3, 1989, 15:33077 (R;US)
OFFSHORE PLATFORMS
Sensitivity study of member stresses to current profile variations, 15:32132 (R;GB)
OHMIC PLASMA LOSSES
See ENERGY LOSSES
OHMIC RESISTANCE
See ELECTRIC CONDUCTIVITY
OIL FIELDS
Critical heterogeneities in a barrier island deposit and their influence on various recovery processes, 15:32127 (J;US)
OIL RESIDUES
See PETROLEUM RESIDUES
OIL SAND OILS
See BITUMENS
OIL SHALE WASTE WATER
See OIL SHALES
WASTE WATER
OIL SHALES
Ammonia evolution from western and eastern oil shales, 15:32188 (BA;US)
History and some potentials of oil shale cement, 15:32190 (R;US)
Oil shale quarterly report, April–December 1989, 15:32186 (R;US)
Study of eastern and western oil shale minerals activity for hydrodesulfurization (HDS) and hydrodenitrogenation (HDN) reactions, 15:32189 (BA;US)
OIL WELLS
Absorption properties of carbon dioxide enhanced-oil-recovery additives. Final Technical report, 12 May 1987-31 August 1989, 15:32133 (R;US)
Capillary suction-time tests on selected clays and shales. Master's thesis, 15:32128 (R;US)
Contribution to the analytical and numerical evaluation of oil well equilibrium for any cross section under a uniform pressure and an anisotropic stress field, 15:32130 (R;FR;In French)
Prediction of miscible flood performance: The effect of dispersion on composition paths in ternary systems, 15:32135 (J;US)
Real-time bit-wear estimation using surface-vibration signals. Phase 1, 15:33007 (R;US)
OLEFINS
See ALKENES
OMEGA-1778 RESONANCES
See MESONS
ON-LINE COMPUTERS
See COMPUTERS
ONCOGENES
v-src induces clonal sarcomas and rapid metastasis following transduction with a replication-defective retrovirus, 15:33207 (J;US)
ONTARIO
Report on the 1988 industrial direct discharges in Ontario, 15:33066 (R;CA)
OPTICAL EQUIPMENT
Soliton-collision interferometer for the quantum nondemolition measurement of photon number: numerical results, 15:32996 (J;US)
OPTICAL FIBERS
High-power Nd:glass laser transmission through optical fibers and its use in acceleration of thin foil targets, 15:32999 (J;US)
Soliton-collision interferometer for the quantum nondemolition measurement of photon number: numerical results, 15:32996 (J;US)
OPTICAL MICROSCOPES
The Berkeley atomic resolution microscope: An update, 15:33012 (BA;US)
OPTICAL SPECTROMETERS
Apparatus for measurement of spectral line profile, 15:33746 (RA;CS)
OPTICAL SYSTEMS
Calculation of ion channeling directions in low symmetry optical materials, 15:32643 (BA;US)
The chemistry and physics of nonlinear optical materials: A new look at an old field, 15:32994 (BA;US)

ORBITS
Orbit calculations and lattice parameters for the BNL [Brookhaven National Laboratory] SXLS [Superconducting X-Ray Lithography Source]: Part 2, Betatron functions in the superconducting bending magnet and synchrotron radiation integrals, 15:32920 (R;US)
Using the XPATHS computer code, 15:32855 (R;US)

ORE RESERVES
See RESERVES

ORGANIC CHLORINE COMPOUNDS
See also CHLORINATED ALIPHATIC HYDROCARBONS
CHLORINATED AROMATIC HYDROCARBONS
METHYLENE CHLORIDE
Dechlorination of pentachlorophenol, 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid in anaerobic freshwater sediments, 15:33148 (R;US)
PEPICO [photoelectron photoion coincidence] studies of ion dissociations: The structure and heats of formation of ions, molecules, and free radicals: Progress report, April 1989–March 1990, 15:32804 (R;US)
Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the Salton Sea Area, California, 1986-87. Water-Resources investigation, 15:33164 (R;US)
Sulfur species in perchloroethylene and other coal extracts, 15:32780 (R;US)

ORGANIC COMPOUNDS
See also AROMATICS
HYDROCARBONS
LIPIDS
ORGANIC SULFUR COMPOUNDS
ORGANOMETALLIC COMPOUNDS
PROTEINS
Air Emissions Species Manual. Volume 2. Particulate-matter Species Profiles. Second edition. Final report, April 1988-October 1989, 15:33083 (R;US)
Air-Emissions-Species Manual. Volume 1. Volatile-organic-compound species profiles. Second edition. Final report, April 1988-October 1989, 15:33087 (R;US)
Emissions involved in acidic deposition processes: Methodology and results, 15:33048 (R;US)
Estimation of emissions from charcoal lighter fluid and review of alternatives. Final report, 15:33088 (R;US)
Inhibition of retrogressive reactions in coal/petroleum coprocessing: Quarterly technical progress report, December 1, 1989–February 28, 1990, 15:32053 (R;US)
Interlaboratory methods comparison for the total organic carbon analysis of aquifer materials, 15:33170 (R;US)
Modeling organic-contaminant sorption impacts on aquifer restoration, 15:33169 (R;US)
Soil gas surveying at low-level radioactive waste sites, 15:32215 (R;US)
Volatile organic compound and particulate-matter speciation data base (for microcomputers). Data file, 15:33096 (R;US)

ORGANIC FLUORINE COMPOUNDS
A perfluorocarbon tracer transport and dispersion experiment in the North Sea Ekofisk oil field: Revision, 15:33116 (R;US)
A preliminary evaluation of ADPIC [atmospheric diffusion particle-in-cell] model performance on selected ANATEX [Across North America Tracer Experiment] releases using observed, analyzed, and dynamically predicted winds, 15:33109 (R;US)

ORGANIC ION EXCHANGERS
Decontamination impacts on solidification and waste disposal, 15:32200 (R;US)

ORGANIC MATTER
See also KEROGEN
Local structure evaluation in solid amorphous mixtures by double cross polarization C13 nuclear magnetic resonance spectrometry, 15:32086 (BA;US)

ORGANIC SOLVENTS
Health-hazard evaluation report HETA 89-007-1983, St. Thomas More Hospital, Canyon City, Colorado, 15:33236 (R;US)
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ORGANIC SULFUR COMPOUNDS
See also BEDT-TTF
POLYCYCLIC SULFUR HETEROCYCLES
THIOPHENE
XANTHATES
New analytical methods for organic sulfur in coal, 15:32085 (BA;US)
On the nature of organosulfur constituents in Rasa lignite, 15:32107 (BA;US)
Studies of the energetics of C-S bond-breaking reactions in radical ions derived from coal model compounds, 15:32084 (RA;US)

ORGANIC WASTES
Coupled biological downflow fluid bed reactor treatment of synfuels wastewater, 15:33189 (BA;US)

ORGANOMETALLIC COMPOUNDS
A comparison between energetics of decomposition and photodeposition of Pd and Pt from $Pd(C_5H_5)(C_3H_5)$ and $Pt(C_5H_5)$, 15:32735 (BA;US)

ORGDP
Management information systems for environmental compliance activities, 15:32205 (R;US)

ORNL
Management information systems for environmental compliance activities, 15:32205 (R;US)

OSMIUM COMPLEXES
Infrared spectra of C_2 hydrocarbon ligands coordinated to a triosmium framework: The effect of high pressure as a tool for assignment, 15:32814 (J;US)

OSMIUM COMPOUNDS
Effect of transition-metal substitutions on competing electronic transitions in the heavy-electron compound URu_2Si_2, 15:32761 (J;US)

OUTPUT
See PRODUCTION

OXIDASES
See OXIDOREDUCTASES

OXIDES
See also ALUMINIUM OXIDES
ANTIMONY OXIDES
BARIUM OXIDES
BISMUTH OXIDES
CALCIUM OXIDES
CERIUM OXIDES
COBALT OXIDES
COPPER OXIDES
EUROPIUM OXIDES
GADOLINIUM OXIDES
INDIUM OXIDES
IRON OXIDES
LANTHANUM OXIDES
LEAD OXIDES
LITHIUM OXIDES
NEODYMIUM OXIDES
NICKEL OXIDES
NIOBIUM OXIDES
NITROGEN OXIDES
PALLADIUM OXIDES
POTASSIUM OXIDES
PRASEODYMIUM OXIDES
SAMARIUM OXIDES
SILICON OXIDES
STRONTIUM OXIDES
SULFUR OXIDES
TANTALUM OXIDES
THALLIUM OXIDES
THORIUM OXIDES
TIN OXIDES
TITANIUM OXIDES
VANADIUM OXIDES
YTTRIUM OXIDES

ZINC OXIDES
ZIRCONIUM OXIDES
Composition and structure of native oxide on silicon by high resolution analytical electron microscopy, 15:32745 (J;US)
Health and safety guide for inorganic compounds and metals used in the fabrication of superconductive alloys, 15:33234 (R;US)
Radiation effects in magnetic and superconducting materials, 15:32665 (J;US)
[Oxidation of intermetallics and ceramics]: Foreign trip report, March 23, 1990–April 12, 1990, 15:32553 (R;US)

OXIDOREDUCTASES
See also HYDROGENASES
PEROXIDASES
[Hydroxyproline-rich glycoproteins of the plant cell wall]: Progress report, June 1989–June 1990, 15:33193 (R;US)

OXIRANS
See EPOXIDES

OXYGEN
Deuterium interactions with ion-implanted oxygen in Cu and Au, 15:33344 (BA;US)
Indices governing optical self-focusing and self-induced changes in the state of polarization in N_2, O_2, H_2, and Ar gases, 15:32765 (J;US)
Rate constants for the reaction, $O + H_2O \rightarrow OH + OH$, over the temperature range, 1500–2400 K, by the flash photolysis-shock tube technique: A further consideration of the back reaction, 15:32781 (R;US)

OXYGEN 16
Ground state of ^{16}O, 15:33583 (J;US)

OXYGEN 16 TARGET
Full-folding optical potentials in elastic proton-nucleus scattering, 15:33589 (J;US)

OXYGEN 17 REACTIONS
Heavy-ion Coulomb excitation and photon decay of the giant dipole resonance in ^{208}Pb, 15:33554 (J;US)

OXYGEN COMPOUNDS
See also CARBONATES
CUPRATES
NIOBATES
NITRATES
OXIDES
SILICATES
SULFATES
WATER
High-temperature defect structure of Nb-doped $LaCrO_3$, 15:32669 (J;US)

OXYGEN EFFECT (RADIOBIOLOGY)
See OXYGEN

OXYGEN HYDRIDES
See WATER

OXYGEN IONS
Damage formation in semiconductors during MeV ion implantation, 15:32740 (BA;US)

OXYMETHYLENE
See FORMALDEHYDE

OZONE
Atmospheric ozone 1985: Assessment of our understanding of the processes controlling its present distribution and change. Volume 3, 15:33078 (R;CH)
Evaluation of the role of ozone, acid deposition, and other airborne pollutants in the forests of eastern North America. Forest Service general technical report, 15:33085 (R;US)
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Review, discussion, and summary: Toxicology, 15:33248 (R;US)
Southern California Air Quality Study (SCAQS) description of measurement activities. Final report, 15:33093 (R;US)
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1,2,4,5-TETRAMETHYLBENZENE
See DURENE

1,3,5-TRIAMINO-2,4,6-TRINITROBENZENE
See TATB

P

P CODES
Nuclear power applications of NASA control and diagnostics technology: Volume 3, Users manual: Final report, 15:32343 (R;US)
Obsidian hydration dating: Field, laboratory, and modeling results, 15:33279 (BA;US)
PARTITION: A program for defining the source term/consequence analysis interface in the NUREG–1150 probabilistic risk assessments: User's guide, 15:32417 (R;US)
PRAMIS: Probability Risk Assessment Model Integration System: User's guide, 15:32418 (R;US)

P WAVES (SEISMIC)
See SEISMIC P WAVES

PACIFIC NORTHWEST REGION
See FEDERAL REGION X

PACKAGING
Failure analysis of leakage current in plastic encapsulated packages, 15:33006 (R;XA)
Multichip packaging technology with laser-patterned interconnects, 15:32714 (R;US)

PAH
See POLYCYCLIC AROMATIC HYDROCARBONS

PAINTS
Alternative solvents/technologies for paint stripping: Phase 1, 15:32505 (R;US)

PAKISTAN
Small hydro electric power development in the northern area, Pakistan: A mission report, 15:32276 (R;NO)

PALLADIUM
Moving species during ion mixing in Ge_xSi_{1-x}/metal systems, 15:32760 (J;US)
The energetics associated with the formation of interfaces, multilayers and adlayers, 15:32812 (BA;US)

PALLADIUM 110 TARGET
Excitation-energy sharing in uranium induced dissipative collisions, 15:33540 (R;DE)

PALLADIUM 97
High-spin structure of N=51 ^{96}Rh and ^{97}Pd: A shell-model study, 15:33548 (J;US)

PALLADIUM ALLOYS
Neutron scattering experiments on $YbXCu_4$ and $ErXCu_4$ (X=Au, Pd, and Ag), 15:32591 (J;US)
Preparation, fabrication and properties of a rare earth intermetallic compound - GdPd, 15:32644 (BA;US)

PALLADIUM COMPOUNDS
See also PALLADIUM OXIDES
A comparison between energetics of decomposition and photodeposition of Pd and Pt from $Pd(C_5H_5)(C_3H_5)$ and $Pt(C_5H_5)$, 15:32735 (BA;US)

PALLADIUM OXIDES
Phase control of nanophase materials formed from ultrafine Ti of Pd powders, 15:32623 (BA;US)

PAPER
Counterfeit currency detection by principal component analysis of near infrared reflectance data, 15:32791 (BA;US)

PARAFFINS
See ALKANES

PARAGENES
See PLASMIDS

PARALLEL PROCESSING
Parallelizing the closure computation in automated deduction, 15:33840 (R;US)
Semantic correctness for a parallel object-oriented language, 15:33850 (R;NL)
Using the multistage cube network topology in parallel supercomputers, 15:33856 (J;US)

Visual animation of parallel algorithms for matrix computations, 15:33842 (R;US)

PARATHORMONE
Single-sperm typing: Determination of genetic distance between the $^{G}\gamma$-globulin and parathyroid hormone loci by using the polymerase chain reaction and allele-specific oligomers, 15:33208 (J;US)

PARTIAL DIFFERENTIAL EQUATIONS
See also FOKKER-PLANCK EQUATION
WAVE EQUATIONS
Some overdetermined systems of complex partial differential equations, 15:33690 (R;XA)
The Cousin problems for an overdetermined system of complex partial differential equations, 15:33688 (R;XA)
The Cousin problems in the viewpoint of partial differential equations, 15:33689 (R;XA)

PARTICLE BEAM FUSION ACCELERATOR
See also ELECTRON BEAM FUSION ACCELERATOR
Laser-triggered gas switch improvements on PBEA-II, 15:33829 (BA;US)

PARTICLE BEAMS
Onboard detection of intrinsic Lyα radiation from a neutral particle beam, 15:33041 (R;US)
Plasma lenses for focusing particle beams, 15:32929 (J;US)

PARTICLE KINEMATICS
Kinematic moment invariants for linear Hamiltonian systems, 15:33717 (J;US)

PARTICLE MULTIPLETS
Mass differences of light hadron isomultiplets, 15:33440 (R;BR)

PARTICLE PRODUCTION
See also PHOTOPRODUCTION
Hadron production in a fireball radiation model for electron-positron collisions, 15:33428 (R;BR)

PARTICLE SIZE
Long-term stability of solid standards for radiochemical analysis, 15:32785 (R;US)

PARTICLE-BEAM WEAPONS
See DIRECTED-ENERGY WEAPONS

PARTICLE-INDUCED X-RAY EMISSION ANALYSIS
See X-RAY EMISSION ANALYSIS

PARTICLES
See also DROPLETS
PARTICULATES
Diffusion of noninteracting particles into a semi-infinite lattice, 15:33641 (J;US)

PARTICULATES
Air Emissions Species Manual. Volume 2. Particulate-matter Species Profiles. Second edition. Final report, April 1988-October 1989, 15:33083 (R;US)
Air pollution control using particle filtration. March 1982-March 1990 (A Bibliography from the NTIS data base). Report for March 1982-March 1990, 15:33099 (R;US)
Air-Emissions-Species Manual. Volume 1. Volatile-organic-compound species profiles. Second edition. Final report, April 1988-October 1989, 15:33087 (R;US)
Holographic measurement of ejecta from shocked metal surfaces, 15:32874 (BA;US)
Inhalation Toxicology Research Institute annual report, October 1, 1987–September 30, 1988, 15:33223 (R;US)
Inhalation Toxicology Research Institute annual report, October 1, 1988–September 30, 1989, 15:33224 (R;US)
Mechanics/heat-transfer relation for particulate materials: Quarterly report, 15:32114 (R;US)
Numerical simulations of the mountain iron tracer data, 15:33061 (R;US)
Offgas system particulate cleaning test and evaluation for the Process Experimental Pilot Plant, 15:32216 (R;US)
Southern California Air Quality Study (SCAQS) description of measurement activities. Final report, 15:33093 (R;US)
Urban modeling of organic aerosol source emissions, 15:33047 (R;US)
Volatile organic compound and particulate-matter speciation data base (for microcomputers). Data file, 15:33096 (R;US)

PASSIVE SOLAR COOLING SYSTEMS
Passive cooling, 15:32483 (B;US)

PASSIVE SOLAR HEATING SYSTEMS
Passive cooling, 15:32483 (B;US)

PBFA
See PARTICLE BEAM FUSION ACCELERATOR

PCB
See CHLORINATED AROMATIC HYDROCARBONS

PDU
See PROCESS DEVELOPMENT UNITS

PEATLANDS
See WETLANDS

PENNSYLVANIA
Proximity of Pennsylvania sanitary landfills to wetlands and deep-water habitats: Data on individual landfills, 15:33150 (R;US)

PEOPLE
See HUMAN POPULATIONS

PEOPLES REPUBLIC OF CHINA
See CHINA

PERIPHYTON
See AUFWUCHS

PERMEABILITY
A unified theory of radon transport in porous media: Model benchmark and soil parameter evaluations: Project annual report, 15:33140 (R;US)

PERMUTIT (ORGANIC)
See ORGANIC ION EXCHANGERS

PEROVSKITES
High-pressure phase transitions in the 6H perovskites $Ba_3MSb_2O_9$ (M = Mg, Ni, Zn), 15:32667 (J;US)
Landau-Ginzburg model of interphase boundaries in improper ferroelastic Perovskites of D_{4h}^{18} symmetry, 15:33648 (J;US)
Protons and lattice defects in perovskite-related oxides: Progress report, July 1, 1989–April 30, 1990, 15:32611 (R;US)

PEROXIDASES
[Molecular characteristics of the lignin forming peroxidase]: Progress report, 15:33195 (R;US)

PEROXYACETYL NITRATE
Southern California Air Quality Study (SCAQS) description of measurement activities. Final report, 15:33093 (R;US)

PERSONNEL
See also MILITARY PERSONNEL
REACTOR OPERATORS
Evaluation of the effective equivalent dose in the general public due to the discharge of uranium in groundwater, 15:33600 (R;BR;In Portuguese)
Nuclear Weapon Personnel-Reliability Program. Directive, 15:33019 (R;US)
[Radiological protection of the public from intakes of radionuclides]: Foreign trip report, April 21, 1990–April 27, 1990, 15:33225 (R;US)

PERTURBATIONS
See DISTURBANCES

PESTICIDES
See also HERBICIDES
Cumulative impacts on water-quality functions of wetlands, 15:33173 (R;US)
Effects of valley meteorology on forest pesticide spraying, 15:33219 (R;US)
Toxicity bioassays: Water pollution effects on aquatic animals and plants. June 1986-February 1990 (A bibliography from the Selected Water Resources Abstracts data base). Report for June 1986-February 1990, 15:33183 (R;US)

PETROLEUM
A sulfur isotope data analysis of crude oils from the Bolivar coastal fields (BCF), Venezuela, 15:32164 (BA;US)
A techno-economic evaluation of copressing technologies, 15:32079 (BA;US)
An evaluation of the known remaining oil resource in the State of Texas: Project on Advanced Oil Recovery and the States, 15:32147 (R;US)
Co-processing and tar-sands resid: A new approach to alternative transportation fuels, 15:32078 (BA;US)

Detecting leaks: Successful methods step-by-step. Final report, 15:32162 (R;US)
Drinking water: Safeguards are not preventing contamination from injected oil and gas wastes, 15:32153 (R;US)
Modeling organic-contaminant sorption impacts on aquifer restoration, 15:33169 (R;US)
Petroleum Marketing Monthly, February 1990, 15:32148 (R;US)
Superfund Record of Decision (EPA Region 7): Arkansas City Dump Site, Arkansas City, Kansas (Second remedial action), September 1989. Final report, 15:32155 (R;US)

PETROLEUM COKE
See COKE
PETROLEUM PRODUCTS

PETROLEUM GEOLOGY
Petroleum system: Status of research and methods, 1990. Bulletin, 15:32126 (R;US)

PETROLEUM INDUSTRY
Energy security: Analysis of studies on economic consequences of an oil import tariff, 15:32149 (R;US)
Major chemical accidents: Are we prepared?, 15:32443 (R;CA)
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PETROLEUM PRODUCTS
See also DIESEL FUELS
GASOLINE
Assessing UST corrective action technologies: Site assessment and selection of unsaturated zone treatment technologies. Report for October 1987-September 1989, 15:32159 (R;US)
Development of the oil-water monitor: Quarterly progress report No. 3, 15:33005 (R;US)
Estimation of emissions from charcoal lighter fluid and review of alternatives. Final report, 15:33088 (R;US)
Petroleum Marketing Monthly, February 1990, 15:32148 (R;US)

PETROLEUM REFINERIES
Assessing inhalation risks from the land treatment of petroleum refining wastes, 15:32151 (B;US)

PETROLEUM RESIDUES
Inhibition of retrogressive reactions in coal/petroleum coprocessing: Quarterly technical progress report, December 1, 1989–February 28, 1990, 15:32053 (R;US)

PETROV-GALERKIN METHOD
See GALERKIN-PETROV METHOD

PETT
See POSITRON COMPUTED TOMOGRAPHY

PHAEDRUS MIRROR DEVICES
Mode conversion between Alfven wave eigenmodes in axially inhomogeneous two-ion-species plasmas, 15:33796 (J;US)

PHASE SPACE
Kinematic moment invariants for linear Hamiltonian systems, 15:33717 (J;US)
On the structure of quantum phase space, 15:33704 (R;BR)

PHENOL
Toxicological profile for phenol. Final report, 15:33241 (R;US)

PHENOLS
See also CRESOLS
PHENOL
XYLENOLS
Jet fuels potential of liquid by-products from the Great Plains Gasification Project, 15:32048 (R;US)
Production of jet fuels from coal derived liquids: Volume 6, Preliminary analysis of upgrading alternatives for the Great Plains liquid by-product streams: Interim report, March 1987–February 1988, 15:32058 (R;US)
Production of jet fuels from coal-derived liquids: Volume 12, Preliminary process design and cost estimate and production run recommendation: Final report, March 1989–December 1989, 15:32060 (R;US)

PHI4-FIELD THEORY
On a phase structure of a three-dimensional ϕ^4 field theory, 15:33501 (R;XA)

PHONONS
A time-resolved x-ray scattering technique for observation of non-equilibrium phonons, 15:32742 (J;US)
Entropy and Effective temperature in second RPA dynamics, 15:33574 (R;FR)

PHOSPHORUS SULFIDES
Glasses in the system phosphorus-sulfur: A ^{31}P spin-echo and high-speed MAS-NMR study of atomic distribution and local order, 15:32816 (J;US)

PHOTOCHEMICAL ENERGY STORAGE
Chlorophyll photochemistry in microheterogeneous media, 15:32279 (R;US)

PHOTOCHEMICAL REACTIONS
Chlorophyll photochemistry in microheterogeneous media, 15:32279 (R;US)

PHOTODETECTORS
Photoluminescence spectroscopy of thin indium-tin-oxide contracts on mercuric iodide substrates, 15:32632 (BA;US)

PHOTODIODES
Improving the performance of $InAs_{1-x}Sb_x/InSb$ infrared detectors grown by metal organic chemical vapor deposition, 15:32711 (R;US)

PHOTODISINTEGRATION
See PHOTONUCLEAR REACTIONS

PHOTOELECTROCHEMICAL CELLS
Mechanistic aspects of reductions by hot electrons in p-InP/acetonitrile photoelectrochemical cells, 15:32824 (J;US)

PHOTOMAGNETOELECTRIC EFFECT
See MAGNETIC FIELDS

PHOTON BEAMS
An experimental study of the A-dependence of J/psi photoproduction, 15:33527 (R;BR)

PHOTON DETECTION (X-RAY)
See X-RAY DETECTION

PHOTON-LEPTON INTERACTIONS
Multi-laser beam accelerator, 15:33819 (RA;JP)

PHOTON-PHOTON INTERACTIONS
Measurement of the two-photon width of the η and η' mesons, 15:33412 (J;US)
Two-photon physics, 15:33406 (R;US)
Vector-meson contributions to the processes $\gamma\gamma \to \pi^0\pi^0, \pi^+\pi^-$, $K_L \to \pi^0\gamma\gamma$, and $K^+ \to \pi^+\gamma\gamma$, 15:33465 (J;US)

PHOTONS
See also COSMIC PHOTONS
A unified description of the perturbative photon structure function in x space, 15:33449 (R;FR)
Correlated two-photon interference in a dual-beam Michelson interferometer, 15:32767 (J;US)
Dosimetry considerations for the high-energy photon/electron environment of HERMES III: Implications for experiments and modeling, 15:32937 (R;US)

PHOTONUCLEAR REACTIONS
Study on (γ, π^+), (γ,π^-xn) rections, photo-spallation and photo-fragmentation reaction, 15:33447 (RA;JP;In Japanese)

PHOTOPRODUCTION
An experimental study of the A-dependence of J/psi photoproduction, 15:33527 (R;BR)
Studies on the separation between higher-twist and minimum-twist in the photoproduction experiment WA69 at the CERN-OMEGA spectrometer, 15:33427 (R;DE;In German)

PHOTOSYNTHETIC MEMBRANES
Isolation of a photoactive photosynthetic reaction center - core antenna complex from Heliobacillus mobilis, 15:32287 (J;US)
Water oxidation in photosystem II: From radical chemistry to multielectron chemistry, 15:32286 (J;US)

PHOTOSYNTHETIC REACTION CENTERS
Isolation of a photoactive photosynthetic reaction center - core antenna complex from Heliobacillus mobilis, 15:32287 (J;US)
Water oxidation in photosystem II: From radical chemistry to multielectron chemistry, 15:32286 (J;US)

PHOTOVOLTAIC POWER SUPPLIES
Solar powered pumping systems. Existing material, cost of a cubic meter, comparison with other pumping systems, maintenance, appendix, 15:32288 (R;FR;In French)

PI-1016 RESONANCES
See MESONS
PIGE ANALYSIS
See PROTON REACTIONS
PIGMENT CELLS
See ANIMAL CELLS
PIGMENTS
PIGMENTS
Anticorrosive pigments. January 1980-December 1989 (A Bibliography from World Surface Coatings Abstracts). Report for January 1980-December 1989, 15:32556 (R;US)
PILES
See FOUNDATIONS
PINEAL GLAND
Extremely low frequency electromagnetic fields: The question of cancer, 15:33259 (B;US)
PINELLAS PLANT
Tiger Team assessment of the Pinellas Plant, 15:33121 (R;US)
PINES
Radionuclide uptake by pinetrees growing on lysimeters, 15:33123 (R;US)
PINNING FORCE
See MAGNETIC FLUX
PINS (FUEL)
See FUEL PINS
PION MINUS REACTIONS
Coulomb-nuclear interference in pion inelastic scattering, 15:33556 (J;US)
Observation of double isovector giant dipole resonances from pion double charge exchange, 15:33535 (J;US)
A dependence of J/ψ production in π^--nucleus collisions at 530 GeV/*c*, 15:33411 (J;US)
PION NEUTRAL REACTIONS
Charged-particle multiplicities following pion absorption on ^{6}Li, 15:33532 (J;US)
PION PLUS REACTIONS
Coulomb-nuclear interference in pion inelastic scattering, 15:33556 (J;US)
Observation of double isovector giant dipole resonances from pion double charge exchange, 15:33535 (J;US)
PIONS
See also PIONS MINUS
PIONS NEUTRAL
PIONS PLUS
Measurement of D^* production in jets from $\bar{p}p$ collisions at $\sqrt{s}$ =1.8 TeV, 15:33413 (J;US)
PIONS MINUS
Vector-meson contributions to the processes $\gamma\gamma\rightarrow\pi^0\pi^0,\pi^+\pi^-$, $K_L\rightarrow\pi^0\gamma\gamma$, and $K^+\rightarrow\pi^+\gamma\gamma$, 15:33465 (J;US)
PIONS NEUTRAL
Neutral pion photoproduction on the nucleon near threshold, 15:33581 (J;US)
Vector-meson contributions to the processes $\gamma\gamma\rightarrow\pi^0\pi^0,\pi^+\pi^-$, $K_L\rightarrow\pi^0\gamma\gamma$, and $K^+\rightarrow\pi^+\gamma\gamma$, 15:33465 (J;US)
PIONS PLUS
Vector-meson contributions to the processes $\gamma\gamma\rightarrow\pi^0\pi^0,\pi^+\pi^-$, $K_L\rightarrow\pi^0\gamma\gamma$, and $K^+\rightarrow\pi^+\gamma\gamma$, 15:33465 (J;US)
PIPELINES
Development of the oil-water monitor: Quarterly progress report No. 3, 15:33005 (R;US)
Natural gas transport by plastic pipes. January 1970-January 1990 (A Bibliography from the COMPENDEX data base). Report for January 1970-January 1990, 15:32180 (R;US)
PIPES
Environmentally assisted cracking in light water reactors, 15:32552 (RA;US)
Insulating coatings (excluding electrical insulation). January 1980-November 1989 (A Bibliography from World Surface Coatings Abstracts). Report for January 1980-November 1989, 15:32487 (R;US)
Verification and benchmarking of ABAQUS and PATRAN for heat transfer applications, 15:32863 (R;US)
PITCHBLENDE
Long-term stability of solid standards for radiochemical analysis, 15:32785 (R;US)
PLANTS
See also ALGAE
SHRUBS
Potential responses of landscape boundaries to global environmental change, 15:33051 (R;US)
Ressac program plants analytical experiments study of a code modelling the soil to plant transfer factor of cesium, 15:33117 (R;FR;In French)
PLANTS (INDUSTRIAL)
See INDUSTRIAL PLANTS
PLASMA
See also COLD PLASMA
COLLISIONAL PLASMA
COLLISIONLESS PLASMA
HIGH-BETA PLASMA
INHOMOGENEOUS PLASMA
LASER-PRODUCED PLASMA
LOW-BETA PLASMA
RELATIVISTIC PLASMA
Burn condition for fusion plasmas, helium particle confinement and exhaust efficiency, 15:33779 (R;DE)
Canonical Hamiltonian guiding center variables, 15:33798 (J;US)
Experimental simulation of a gaseous plasma collector, 15:33834 (J;US)
Measurement of gravitational acceleration of antimatter, 15:33740 (R;XA)
Neoclassical quasilinear transport theory of fluctuations in toroidal plasmas: Further considerations, 15:33794 (J;US)
Simulation of radial expansion of an electron beam injected into a background plasma, 15:32925 (R;US)
Sources of multiply charged ions for heavy-ion fusion, 15:33801 (J;US)
Spatial distribution of atomic and molecular species in inductively coupled plasmas (ICP): By monochromatic imaging and image analysis, 15:32792 (BA;US)
X-ray spectral signatures of photoionized plasmas, 15:33325 (J;US)
PLASMA (QUARK)
See QUARK MATTER
PLASMA ACCELERATION
Cross-field acceleration in plasmas, 15:33780 (RA;JP)
PLASMA ARC SPRAYING
15th Czechoslovak seminar on plasma physics and technology. Part 2, 15:33722 (R;CS;In English, Russian)
Complex experiment in plasma jet spraying of coatings, 15:33627 (RA;CS)
Enhancement of the deposition rate of PAL 160 plasmatrons by using a multiple supply of spray material, 15:33629 (RA;CS;In Russian)
PLASMA CONFINEMENT
See also INERTIAL CONFINEMENT
Canonical Hamiltonian guiding center variables, 15:33798 (J;US)
Configurational effects on plasma confinement in SHEILA, 15:33724 (RA;AU)
PLASMA DENSITY
A novel scanning interferometer for two-dimensional plasma density measurements, 15:33730 (R;AU)
ECH experiments in SHEILA, 15:33725 (RA;AU)
Measurement of the ion temperature in the tokamak TCA by collective Thomson diffusion in the far infrared, 15:33784 (R;CH;In French)
PLASMA DIAGNOSTICS
A diagnostic for 2D density profiles in Heliac H-1, 15:33728 (RA;AU)
Apparatus for measurement of spectral line profile, 15:33746 (RA;CS)
Diagnostic measurements of the pumped divertor plasma, 15:33776 (RA;GB)
Edge density profile studies in the Castor tokamak using a thermal lithium beam, 15:33756 (RA;CS)

Effect of changes in viewing window transmission on high-temperature Thomson scattering data, 15:33800 (J;US)
Electrostatic edge turbulence on CASTOR tokamak, 15:33751 (RA;CS)
K-lines in soft X-ray spectrum and the determination of plasma parameters of Ar Z-pinch, 15:33749 (RA;CS)
Measurement of the Lyman-alpha radiation at ionization manometers for determination of the hydrogen atom number density in fusion experiments, 15:33762 (R;DE;In German)
Particle injection into the Castor tokamak by electric arcs, 15:33753 (RA;CS)
Production of a short hydrogen gas pulse by laser-induced desorption from titanium hydride for investigation of transport processes in fusion plasmas, 15:33761 (R;DE;In German)
Some results of diamagnetic measurements on Rebex machine, 15:33743 (RA;CS)
The potential of CCDs for hot plasma diagnostics, 15:33748 (RA;CS)
Time development of profile of H_α line in REBEX plasma, 15:33745 (RA;CS)
Time resolved diagnostics of hot plasma radiation by Si surface barrier detectors, 15:33747 (RA;CS)
Tokamak radiation measurements by microchannel plate detector, 15:33755 (RA;CS)
X-ray detection using the quantum well exciton nonlinearity, 15:33789 (J;US)

PLASMA DRIFT
Fluctuation and thermal energy balance for drift-wave turbulence, 15:33737 (R;US)
Is the temperature gradient or the derivative of the density gradient responsible for drift solitons?, 15:33741 (R;DE)

PLASMA FLUID EQUATIONS
Modelling the edge plasma dynamics in a tokamak using Grad's approximation, 15:33757 (RA;CS;In Russian)

PLASMA HEATING
See also BEAM INJECTION HEATING
LASER-RADIATION HEATING
Computer simulation of Alfven wave heating, 15:33795 (J;US)
Microwave Tokamak Experiment: Overview and status, 15:33824 (R;US)

PLASMA INSTABILITY
Stabilisation of the vertical plasma position, 15:33770 (RA;GB)
The ion temperature gradient instability in a linear machine, 15:33797 (J;US)

PLASMA JETS
Application of low-temperature plasma generators for intensification of melting processes in induction furnaces, 15:33628 (RA;CS;In Russian)

PLASMA PRODUCTION
CW ultraviolet and visible laser action from ionized silver in an electron beam generated plasma, 15:33790 (J;US)

PLASMA RADIAL PROFILES
A model for the electrostatic turbulence observed in the Castor tokamak, 15:33752 (RA;CS)
Edge density profile studies in the Castor tokamak using a thermal lithium beam, 15:33756 (RA;CS)

PLASMA SHEATH
Smooth plasma-sheath transition in a hydrodynamic model–, 15:33830 (J;US)

PLASMA SIMULATION
Non-stationary computer model of the asymptotic region of an electric arc gas heater, 15:33742 (RA;CS)
Parallel treatment of simulation particle-in-cell codes on SUPRENUM, 15:33782 (R;DE)
Plasma turbulence, 15:33832 (J;US)
Smooth plasma-sheath transition in a hydrodynamic model–, 15:33830 (J;US)

PLASMA SWITCHES
Multiple arc ion sources for heavy ion fusion, 15:33833 (J;US)

PLASMATRONS
Application of low-temperature plasma generators for intensification of melting processes in induction furnaces, 15:33628 (RA;CS;In Russian)
Enhancement of the deposition rate of PAL 160 plasmatrons by using a multiple supply of spray material, 15:33629 (RA;CS;In Russian)

PLASMIDS
DpnA, a methylase for single-strand DNA in the Dpn II restriction system, and its biological function, 15:33203 (J;US)

PLASTIC SCINTILLATION COUNTERS
See PLASTIC SCINTILLATION DETECTORS

PLASTIC SCINTILLATION DETECTORS
Development of a large-area scintillation detector with good spatial resolution, 15:32968 (R;DE;In German)

PLASTICS
Plastics and elastomers: Ozone degradation. January 1973-December 1989 (A Bibliography from the Rubber and Plastics Research Association data base). Report for January 1973-December 1989, 15:32708 (R;US)
Targets of opportunities for plastics recycling and source reduction, 15:32514 (R;US)

PLATES
Graphical analysis of barrel-tamped explosively accelerated flyer plates, 15:33027 (R;US)

PLATINUM BASE ALLOYS
Stacking fault energies, crystal elasticity and their relation to the mechanical properties of $L1_2$-ordered alloys, 15:32561 (BA;US)

PLATINUM COMPOUNDS
A comparison between energetics of decomposition and photodeposition of Pd and Pt from $Pd(C_5H_5)(C_3H_5)$ and $Pt(C_5H_5)$, 15:32735 (BA;US)

PLESIOTHERAPY
See RADIOTHERAPY

PLT DEVICES
On the application of the nonlinear reflection coefficient theory to some lower hybrid experimental results on PLT tokamak, 15:33759 (RA;CS)

PLUMES
Evaluation of the wake effects on plume dispersion using video image analysis, 15:33090 (R;US)
The effect of charge mixture ratio and particle size on igniter plume heat transfer characteristics, 15:32871 (R;US)

PLUTONIUM
[A small-scale study of Rocky Flats uncalcined incinerator ash dissolution and filtrate anion exchange]: Draft, 15:32234 (R;US)

PLUTONIUM 238
Radionuclide uptake by pinetrees growing on lysimeters, 15:33123 (R;US)

PLUTONIUM 239
Pantex Plant site environmental report for calendar year 1988, 15:33062 (R;US)
Radionuclide uptake by pinetrees growing on lysimeters, 15:33123 (R;US)
Rapid determination of plutonium content on filters and smears using Alpha Liquid Scintillation, 15:32974 (R;US)

PLUTONIUM DIOXIDE
Investigation on U - O - Na, Pu - O - Na and U,Pu - O - Na phase diagrams, 15:32603 (R;FR;In French)
[A small-scale study of Rocky Flats uncalcined incinerator ash dissolution and filtrate anion exchange]: Draft, 15:32234 (R;US)

PNA
See POLYCYCLIC AROMATIC HYDROCARBONS

POINT CONTACTS
See ELECTRIC CONTACTS

POINT KERNELS
QADS: A multidimensional point kernel analysis module, 15:33596 (R;US)

POINT MUTATIONS
See GENE MUTATIONS

POISONS (CHEMICAL)
See HAZARDOUS MATERIALS

POLARIZED BEAMS
Sources of spin-polarized beams (invited), 15:32958 (J;US)

POLLUTANTS
Comparison of an unsaturated soil zone model (SESOIL) predictions with a laboratory leaching experiment, 15:33136 (BA;US)

Introduction to the Argonne Utility Simulation (ARGUS) model, 15:32470 (R;US)
Multimedia assessment of health risks for the Weldon Spring site remedial action project, 15:32202 (R;US)
The Argonne Utility Simulation model: An analysis tool for evaluating energy and environmental strategies, 15:32097 (R;US)

POLLUTION CONTROL EQUIPMENT
See also ACOUSTIC AGGLOMERATORS
AIR FILTERS
Air pollution control using particle filtration. March 1982-March 1990 (A Bibliography from the NTIS data base). Report for March 1982-March 1990, 15:33099 (R;US)
Three-stage combustion (reburning) on a full-scale operating boiler in the USSR. Final report, March 1988-January 1990, 15:32316 (R;US)

POLLUTION REGULATIONS
Pretreatment compliance monitoring and enforcement software. User's guide. version 2.0. Final report, 15:33168 (R;US)

POLLUTION SOURCES
Development of an expert-system embedding pattern-recognition techniques for pollution-source identification. Report for 30 September 1987-29 November 1989, 15:33171 (R;US)

POLOIDAL DIVERTORS
See POLOIDAL FIELD DIVERTORS

POLOIDAL FIELD DIVERTORS
Equilibrium configuration for a high current pumped divertor, 15:33769 (RA;GB)
High heat flux components, 15:33773 (RA;GB)
Performance expectations in the new configuration, 15:33777 (RA;GB)
The JET divertor coil, 15:33771 (RA;GB)

POLY(ISOBUTYLENE OXIDE)
See EPOXIDES

POLYACETYLENES
X-ray structure of Cs-doped polyacetylene, 15:32768 (J;US)

POLYATOMIC MOLECULES
The origin of small and large molecule behavior in the vibrational relaxation of highly excited molecules, 15:32821 (J;US)

POLYCRYSTALS
Fracto-emission from deuterated titanium: Supporting evidence for a fracto-fusion mechanism, 15:33791 (J;US)

POLYCYCLIC AROMATIC HYDROCARBONS
Analysis of mutagenic activity of biohazardous organics in Kanawha River sediments. Technical completion report, 15:33181 (R;US)
Cumulative impacts on water-quality functions of wetlands, 15:33173 (R;US)
Enhanced fluorescence and Raman analysis of DNA-adduct products, 15:32793 (BA;US)
Fluorescence line narrowing spectrometry: A versatile tool for the study of chemically initiated carcinogenesis, 15:33197 (BA;US)
Poly aromatic hydrocarbons in flue gas from straw-fueled boilers: Pilot investigation, 15:32271 (R;DK;In Danish)
Technology evaluation report: SITE program. CF Systems organics extraction system, New Bedford, Massachusetts. Volume 1. Final report, 15:33178 (R;US)
Technology evaluation report: SITE program. CF Systems organics extraction system, New Bedford, Massachusetts. Volume 2. Final report, 15:33179 (R;US)
Toxicity of aromatic polycyclic hydrocarbons. January 1988-October 1989 (A Bibliography from the Life Sciences Collection data base). Report for January 1988-October 1989, 15:33255 (R;US)

POLYCYCLIC SULFUR HETEROCYCLES
Genetic approach to microbial coal desulfurization, 15:32056 (RA;US)
Microbial removal of organic sulfur from coal (bacterial degradation of sulfur containing heterocyclic compounds), 15:32055 (RA;US)

POLYMERS
See also ELASTOMERS
A new approach in ultrapurification of coal by selective flocculation: Quarterly report, 15:32052 (R;US)
Glancing incidence neutron scattering, 15:33614 (R;FR)
Polymers, fractals, and ceramic materials, 15:32671 (J;US)
The infrared microspectroscopic determination of a polymer dopant using partial and classical least-squares chemometric methods, 15:32794 (BA;US)
Utilization of polymer viscoelastic properties in acoustic wave sensor applications, 15:33008 (R;US)

POLYNOMIALS
Recurrence relations and weight functions for approximation by orthonormal polynomials, 15:33680 (R;XA)

POLYNUCLEAR AROMATIC HYDROCARBONS
See POLYCYCLIC AROMATIC HYDROCARBONS

POLYPEPTIDES
Localization versus delocalization of the Davydov soliton: Dispersive collapse under the Schroedinger equation, 15:33201 (J;US)

POLYTHIONATES
See OXYGEN COMPOUNDS

POLYTHIONIC ACIDS
See OXYGEN COMPOUNDS

POLYVINYL CHLORIDE
See PVC

PONDS
Evaluation of detention-basin performance in the Piedmont region of North Carolina, 15:33180 (R;US)
Superfund Record of Decision (EPA Region 6): Sheridan Disposal Services Site, Waller County, Texas (Second remedial action), September 1989. Final report, 15:33177 (R;US)

POOLS
See PONDS

POROUS MATERIALS
FRAC-UNIX theory and user's manual, 15:32298 (R;US)
Report on once-through column experiments with carbon-14, 15:32221 (R;DE;In German)
Rigorous bounds on the fluid permeability: Effect of polydispersivity in grain size, 15:33389 (J;US)

PORPHYRINS
See also CHLOROPHYLL
Geoporphyrin analysis using an ion trap mass spectrometer, 15:32165 (BA;US)

POSITION SENSITIVE DETECTORS
Development of a large-area scintillation detector with good spatial resolution, 15:32968 (R;DE;In German)

POSITRON BEAMS
Efficient energy spectrometer for charged particle detection in surface studies, 15:32982 (J;US)

POSITRON COMPUTED TOMOGRAPHY
Positron Emission Tomography with improved spatial resolution: The ninth months technical report, 15:33213 (R;US)

POSITRON DECAY
See BETA-PLUS DECAY

POSITRONIUM
Positron–hydrogen-atom *S*-wave coupled-channel scattering at low energies, 15:33369 (J;US)

POSITRONS
Positron-annihilation momentum density in superconductors, 15:33657 (J;US)

POTABLE WATER
See DRINKING WATER

POTASSIUM
Core-level photoemission from alkali metals on Ru(001), 15:32594 (J;US)
Formation of excited hydrogen states in stimulated desorption from an alkali-promoted surface, 15:33637 (J;US)
The ionization of thermal and hyperthermal beams of Na, K, and Cs on Si(111) surfaces, 15:33646 (J;US)

POTASSIUM 40
An aerial radiological survey of the Evans Area, US Army Communications-Electronics Command, Fort Monmouth, New Jersey: Date of survey, November 1988, 15:33055 (R;US)

POTASSIUM COMPOUNDS
See also POTASSIUM OXIDES
POTASSIUM PERCHLORATES
POTASSIUM PHOSPHATES

Low-frequency relaxation modes and structural disorder in $KTa_{1-x}Nb_xO_3$, 15:32764 (J;US)

POTASSIUM OXIDES
$BaBiO_3$ and the effect of potassium substitution using photoemission, 15:32684 (J;US)
Characterization of $KNbO_3$ thin films deposited by ion beam sputtering using a computer-controlled rotating target holder, 15:32635 (BA;US)
Effect of electron and volume change via SB (V) doping on the superconducting behavior of $K_{0.14}Ba_{0.6}Bi_{1-x}Sb_xO_3$, 15:32625 (BA;US)
O 2*p* holes: Temperature effects and surface characteristics of cuprate superconductors, 15:32689 (J;US)
Preparation and characterization of single phase $Ba_{1-x3}K_xBiO_3$, 15:32651 (BA;US)
Protons and lattice defects in perovskite-related oxides: Progress report, July 1, 1989–April 30, 1990, 15:32611 (R;US)

POTASSIUM PERCHLORATES
The effect of charge mixture ratio and particle size on igniter plume heat transfer characteristics, 15:32871 (R;US)

POTASSIUM PHOSPHATES
Correlated two-photon interference in a dual-beam Michelson interferometer, 15:32767 (J;US)

POTOMAC RIVER
Long-term benthic monitoring studies in the freshwater portion of the Potomac River: 1983 to 1985, cumulative report. Volume 1. Text, 15:33143 (R;US)
Long-term benthic monitoring studies in the freshwater portion of the Potomac River: 1983 to 1985, cumulative report. Volume 2. Appendices, 15:33144 (R;US)

POWER DISTRIBUTION
Reliability differentiated pricing of electricity service, 15:32436 (R;US)

POWER DISTRIBUTION SYSTEMS
Impact of automated feeder reconfiguration on capacity utilization at the Athens Utilities Board, 15:32429 (R;US)

POWER GENERATION
See also COGENERATION
Introduction to the Argonne Utility Simulation (ARGUS) model, 15:32470 (R;US)
Semiannual Compilation of Project Briefs, February 1990 (Power Information Center), 15:33860 (R;US)
The BENCHMARK™ code: Simulation of hourly generation: User's guide, 15:32430 (R;US)

POWER REACTORS
See also COMANCHE PEAK-1 REACTOR
ENEL-4 REACTOR
GRAND GULF-1 REACTOR
JPDR REACTOR
LOVIISA-1 REACTOR
SHIPPINGPORT REACTOR
SPACE POWER REACTORS
SURRY-1 REACTOR
THREE MILE ISLAND-2 REACTOR
Nuclear regulation: NRC's decommissioning procedures and criteria need to be strengthened, 15:32349 (R;US)
Risks and nuclear insurance, 15:32368 (R;IT)
Special Wasteform Lysimeter Program wasteform characteristics, 15:32214 (R;US)

POWER SYSTEMS
An oscillation detector used in the BPA power system disturbance monitor, 15:32431 (J;US)
Initial results in prony analysis of power system response signals, 15:32432 (J;US)
Transportation and operations aspects of space energy systems, 15:32263 (RA;US)

POWER TRANSMISSION
See also LASER POWER TRANSMISSION
Grid-interconnection requirements for small cogeneration systems - Appendix. Final report, September 1985-December 1987, 15:32517 (R;US)
Investigation of effects of 60-Hz electric and magnetic fields on operant and social behavior and on the neuroendocrine system of nonhuman primates: Annual report, 15:32435 (R;US)

POWER TRANSMISSION LINES
Extremely low frequency electromagnetic fields: The question of cancer, 15:33259 (B;US)
The response of MOV and SiC arresters to steep-front longer duration current pulses, 15:32434 (R;US)

PRASEODYMIUM OXIDES
Magnetic ordering in $(Y_{1-x}Pr_x)Ba_2Cu_3O_7$ as observed by muon-spin relaxation, 15:32693 (J;US)
Magnetism, specific heat, and pressure-dependent reistivity of the electron-doped compounds LnMCuO(Ln = Pr,Nd,Sm,Eu,Gd:M = Ce,Th), 15:32641 (BA;US)

PRECIPITATION SCAVENGING
Numerical simulation of aerosol scavenging by ice-bearing convective clouds, 15:33104 (R;US)
Parameterization of aerosol scavenging in a convective cloud model, 15:33105 (R;US)

PRESSURE VESSELS
A multipurpose miniature diamond anvil cell, 15:33014 (J;US)
A probabilistic approach to the evaluation of the PTS [pressurized thermal shock] issue, 15:32356 (R;US)
Environmentally assisted cracking in light water reactors, 15:32552 (RA;US)
Neutron exposure parameters for the metallurgical test specimens in the sixth heavy-section steel irradiation series, 15:32338 (R;US)
Parametric CONTAIN calculations of the containment response of the Grand Gulf plant due to reactor pressure vessel failure at high pressure, 15:32382 (RA;US)

PRESSURIZED WATER COOLED MODERATED REACTOR
See PWR TYPE REACTORS

PRESSURIZED WATER REACTORS
See PWR TYPE REACTORS

PRINCETON LARGE TORUS
See PLT DEVICES

PROBES
Mechanics/heat-transfer relation for particulate materials: Quarterly report, 15:32114 (R;US)
The influence of thickness and wavelength on the mechanical properties of a compositionally modulated ceramic thin film, 15:32628 (BA;US)

PROCESS DEVELOPMENT UNITS
Development of an advanced, continuous mild gasification process for the production of co-products: Quarterly technical progress report, October–December 1989, 15:32051 (R;US)

PROCESS HEAT REACTORS
Analysis of economics and market for urban nuclear heating in China, 15:32330 (R;CN;In English and Chinese)

PROCESSING
See also WASTE PROCESSING
Small angle neutron scattering from nanophase titanium as a function of oxidation, 15:32622 (BA;US)

PROCESSING (WASTES)
See WASTE PROCESSING

PRODUCTION
Western states enhanced oil shale recovery program: Shale oil production facilities conceptual design studies report, 15:32185 (R;US)

PRODUCTION (PARTICLE)
See PARTICLE PRODUCTION

PRODUCTION (PLASMA)
See PLASMA PRODUCTION

PRODUCTION REACTORS
Development of a PIRT (phenomena identification and ranking table) for a postulated double-ended guillotine break in a production reactor, 15:32359 (R;US)

PRODUCTIVITY
Comparative performance analysis: Commercial cut-flower rose production, 15:33218 (R;US)

PROGRAMMING
See also PARALLEL PROCESSING
Analysis of shared data structures for compile-time garbage collection in logic programs, 15:33843 (R;US)

PROJECTILES
Design of a gun system for in-situ compressive strength measurements, 15:33037 (R;US)
PROMINENCES (SOLAR)
See SOLAR PROMINENCES
PRONY METHOD
Initial results in prony analysis of power system response signals, 15:32432 (J;US)
PROPELLANTS
Destruction of propellant components in supercritical water, 15:32806 (R;US)
PROPOSALS
Guide for technical analysis of budget proposals for financial assistance, 15:33837 (R;US)
Guide for technical analysis of cost proposals for acquisition contracts, 15:33836 (R;US)
PROTECTION
See SAFETY
PROTECTION (RADIATION)
See RADIATION PROTECTION
PROTECTIVE COATINGS
Energy beam treatment for improved adhesion of coatings to surfaces, 15:32697 (P;US)
Tribology of amorphous alloys formed with ion beams, 15:32573 (BA;US)
PROTEINS
See also GLYCOPROTEINS
Capillary electrophoresis combined with mass spectrometry, 15:33198 (BA;US)
Description and validation of a method for simultaneous estimation of effective population size and mutation rate from human population data, 15:33209 (J;US)
Localization versus delocalization of the Davydov soliton: Dispersive collapse under the Schroedinger equation, 15:33201 (J;US)
Role of acyl carrier protein isoforms in plant lipid metabolism: Progress report, 15:33194 (R;US)
Theoretical analysis of resonance Raman spectra from the blue copper protein azurin, 15:33202 (J;US)
PROTON DETECTION
Inclusive results at 90^0, at I.S.R., favourable to a diquark understructure of the proton, and estimations of quantum chromodynamics, 15:33409 (R;FR;In French)
PROTON REACTIONS
Analyzing powers for $\vec{p}+^{208}$Pb at large momentum transfers, 15:33557 (J;US)
Forward scattering of a proton from a J=1 nucleus: Selection rules for flipping the spin of the target by two units, 15:33580 (J;US)
Full-folding optical potentials in elastic proton-nucleus scattering, 15:33589 (J;US)
Intermediate mass fragment emission in the 161-MeV p+Ag reaction, 15:33542 (J;US)
Possible evidence for four-particle, four-hole excitations in ^{146}Gd, 15:33582 (J;US)
A dependence of highly inelastic p-nucleus collisions, 15:33418 (J;US)
PROTON-ANTIPROTON INTERACTIONS
Effective fire-tube and geometric scaling in proton-proton and proton-antiproton collisions, 15:33564 (R;BR)
Measurement of D^* production in jets from $\bar{p}p$ collisions at $\sqrt{s}$ =1.8 TeV, 15:33413 (J;US)
Probing the $WW\gamma$ vertex at the Fermilab Tevatron Collider, 15:33422 (J;US)
Recognizing the next heavy quark at $p\bar{p}$ colliders, 15:33452 (J;US)
Search for a light Higgs boson at the Fermilab Tevatron proton-antiproton collider, 15:33424 (J;US)
The reaction anti pp → anti ΛΛ 92 MeV above the reaction threshold, 15:33402 (R;DE;In German)
Two-jet invariant-mass distribution at $\sqrt{s}$ =1.8 TeV, 15:33425 (J;US)
Weak-boson production by charm quarks, 15:33421 (J;US)
W-boson-plus-two-jet production at the Fermilab Tevatron, 15:33453 (J;US)
PROTON-NEUTRON INTERACTIONS
Neutron-proton scattering, 15:33444 (R;DE)
PROTON-PROTON INTERACTIONS
Effective fire-tube and geometric scaling in proton-proton and proton-antiproton collisions, 15:33564 (R;BR)
Elastic scattering and total cross sections, 15:33407 (R;US)
Gluon fusion as a source for massive-quark polarization, 15:33470 (J;US)
Phenomenological study of the polarized lepto production, 15:33448 (R;FR)
Topological soliton model calculation of the proton-proton parity-violating interaction, 15:33460 (J;US)
PROTONS
See also COSMIC PROTONS
Comments on "Neutron-proton mass difference in the chiral solitonic bag model", 15:33584 (J;US)
Higher-order corrections to the scalar quark density in the proton, 15:33457 (J;US)
Precise extractions of the x and Q^2 dependence of $R = \sigma_L/\sigma_T$, F_{2p}, F_{2d}, and $F_{2n}/_{2p}$ from a combined analysis of SLAC [Stanford Linear Accelerator Center] deep inelastic electron scattering experiments, 15:33433 (R;US)
Recommended Bethe–Bloch stopping power parameters for Kapton and Havar, 15:33598 (J;US)
PSEUDOMONAS
Monitoring for genetically engineered pseudomonas species in monterey county, 15:32282 (R;US)
PSI RESONANCES
See MESONS
PSI-3105 RESONANCES
See J PSI-3097 MESONS
PSI-4028 RESONANCES
See PSI-4030 MESONS
PSI-4030 MESONS
Radiative corrections and semileptonic B decays, 15:33471 (J;US)
PSI-4300 RESONANCES
See MESONS
PUBLIC HEALTH
North Slope investigation report, 15:33135 (R;US)
PUBLIC LANDS
Volume estimate of radium-contaminated soil in a section of Barrows Field Park, Glen Ridge, New Jersey, November–December 1989, 15:33115 (R;US)
PUBLIC UTILITIES
See also ELECTRIC UTILITIES
Natural gas requirements for electricity generation through 2000: Can the natural gas industry meet them?: Volume 2, Appendix B, Gas supply issues: Final report, 15:32175 (R;US)
Natural gas requirements for electricity generation through 2000: Can the natural gas industry meet them?: Volume 1: Final report, 15:32174 (R;US)
PULMONARY CANCER
See CARCINOMAS
PULMONARY LAVAGE
See LUNGS
PULSARS
Millisecond-pulsar constraint on cosmic strings, 15:33324 (J;US)
Pulsar magnetospheres with jets, 15:33323 (J;US)
PULSE AMPLIFIERS
Excitation of pulsed flashlamps with a linear response high power amplifier, 15:32891 (BA;US)
PULSE COLUMNS
See EXTRACTION COLUMNS
PULSE GENERATORS
S100 lathe bed pulse generator applied to pulsed nuclear magnetic resonance, 15:33003 (R;BR;In Portuguese)
PULSES
See also ELECTROMAGNETIC PULSES
Interferometric second-harmonic-generation autocorrelator for characterizing femtosecond pulses, 15:32993 (R;US)
PULVERIZED FUEL ASH
See FLY ASH

PURPURA
Unusual formaldehyde-induced hypersensitivity in two schoolgirls, 15:33257 (R;US)
PVC
Vinyl chloride and polyvinyl chloride: Toxicology. April 1978-November 1989 (A Bibliography from the Life Sciences Collection data base). Report for April 1978-November 1989, 15:33251 (R;US)
PWR TYPE REACTORS
See also COMANCHE PEAK-1 REACTOR
LOFT REACTOR
SHIPPINGPORT REACTOR
SIZEWELL-B REACTOR
SURRY-1 REACTOR
THREE MILE ISLAND-2 REACTOR
Aging
Aging risk assessment methodology: Demonstration study on a PWR auxiliary feedwater system, 15:32406 (RA;US)
Auxiliary Water Systems
Aging risk assessment methodology: Demonstration study on a PWR auxiliary feedwater system, 15:32406 (RA;US)
Containment Shells
Comparison between calculated and measured eigenfrequencies for spherical steel containment shells, 15:32389 (RA;US)
Containment Systems
Containment long-term operational integrity--a 1988 status report, 15:32377 (RA;US)
Corium
Thermal behavior of cohesive debris beds in a degraded nuclear reactor, 15:32319 (R;US)
Design Basis Accidents
Reactivity accidents: A reassessment of the design-basis events, 15:32402 (RA;US)
Eccs
Data report for ROSA-IV LSTF 5% cold leg break LOCA experiment Run SB-CL-08, 15:32370 (R;JP)
Evaluation report on CCTF Core-II reflood test C2-AA2 (Run 58): Investigation of downcomer injection effects, 15:32373 (R;JP)
Loss Of Coolant
Data report for ROSA-IV LSTF 5% cold leg break LOCA experiment Run SB-CL-08, 15:32370 (R;JP)
Data report for ROSA-IV LSTF 5% hot leg break experiment Run SB-HL-01, 15:32372 (R;JP)
Development of a PIRT (phenomena identification and ranking table) for a postulated double-ended guillotine break in a production reactor, 15:32359 (R;US)
Modelling of the steam-water-countercurrent flow in the rewetting and flooding phase after loss-of-coolant accidents in pressurized water reactors, 15:32366 (R;DE;In German)
The RELAP5/MOD3 computer code, 15:32363 (R;US)
M Codes
A model for a recovery of a badly degraded core, 15:32361 (R;US)
Meltdown
A model for a recovery of a badly degraded core, 15:32361 (R;US)
Fission product release as a function of chemistry and fuel morphology, 15:32345 (R;US)
Pressure Vessels
A probabilistic approach to the evaluation of the PTS [pressurized thermal shock] issue, 15:32356 (R;US)
Reactor Accidents
RELAP5 thermal-hydraulic analysis of the SNUPPS [Standardized Nuclear Unit Power Plant System] pressurized water reactor, 15:32422 (R;US)
Reactor Components
Mechanical damage experience in major light water reactor systems, 15:32364 (R;US)
Reactor Control Systems
Nuclear power applications of NASA control and diagnostics technology: Volume 1, Project results: Final report, 15:32341 (R;US)
Reactor Monitoring Systems
Nuclear power applications of NASA control and diagnostics technology: Volume 1, Project results: Final report, 15:32341 (R;US)
Steam Generators
Life assessment procedures for major LWR components, 15:32407 (RA;US)
United Kingdom
The case for coal: Evidence by the Coalfield Communities Campaign to the Hinkley Point 'C' nuclear power station inquiry, 15:32329 (R;GB)
PYRENE
Inhibition of retrogressive reactions in coal/petroleum coprocessing: Quarterly technical progress report, December 1, 1989--February 28, 1990, 15:32053 (R;US)
PYRIDINIUM COMPOUNDS
Surface-enhanced resonance Raman scattering from methylviologen at a silver electrode: Evidence for two distinct adsorption interactions, 15:32827 (J;US)
PYRITE
Enhancement of surface properties for coal beneficiation: Technical progress report, January 1, 1990--March 31, 1990, 15:32083 (R;US)
Genetic manipolation of acidophilic bacteria, 15:32077 (BA;US)
PYRITES
See PYRITE
PYROTECHNIC DEVICES
Modeling laser ignition of explosives and pyrotechnics: Effects and characterization of radiative transfer, 15:33028 (R;US)
PZT
Characterization of chemically prepared PZT thin films, 15:32712 (R;US)

Q

Q CODES
QADS: A multidimensional point kernel analysis module, 15:33596 (R;US)
QUANTIZATION
BRS invariant stochastic quantization of Einstein gravity, 15:33705 (R;JP)
QUANTUM CHROMODYNAMICS
Cut-off and effective meson field theory, 15:33431 (R;FR)
Gauge-invariant, nonperturbative approach to the infrared-finite bound-state problem in QCD, 15:33504 (R;HU)
QCD thermodynamics with eight time slices, 15:33516 (J;US)
The calculation of the quark distribution amplitude of the $\Delta^{3/2+}(1232)$ respectively the $\Delta^{1/2-}(1600)$ by means of the QCD sum rules for the determination of the N→Δ transition form factor at $Q^2 \simeq 10$ GeV^2, 15:33426 (R;DE;In German)
The good, the bad, and the baryon, 15:33450 (R;DK)
QUANTUM ELECTRODYNAMICS
QED potentials in many-electron atoms, 15:33350 (J;US)
Relativistic calculation, in quantum electrodynamic, of the Compton diffusion on a bound electron, 15:33510 (R;FR;In French)
QUANTUM ELECTRONICS
Atoms in strong, oscillating electric fields: momentum-space solutions of the time-dependent, three-dimensional Schroedinger equation, 15:33357 (J;US)
Generation of optical harmonics by intense pulses of laser radiation. II. Single-atom spectrum for xenon, 15:33352 (J;US)
Laser effects in photoionization: numerical solution of coupled equations for a three-dimensional Coulomb potential, 15:33356 (J;US)
Strong-field laser ionization of alkali atoms using two-dimensional cylindrical and three-dimensional Cartesian time-dependent Hartree--Fock theory, 15:33358 (J;US)
Testing of laser-dressed atomic states, 15:33351 (J;US)
The many faces of resonances in multiphoton ionization, 15:33348 (J;US)
Variable time-step integrator for intense field dynamics, 15:33359 (J;US)
QUANTUM FIELD THEORY
See also LAGRANGIAN FIELD THEORY
LATTICE FIELD THEORY
PHI4-FIELD THEORY
QUANTUM CHROMODYNAMICS

QUANTUM ELECTRODYNAMICS
QUANTUM GRAVITY

Anyons and Chern-Simons theory on compact spaces of finite genus, 15:33497 (R;XA)
Classical extended conformal symmetries, 15:33502 (R;XA)
Higher loop contributions to effective potential of gauge theory at high temperature, 15:33487 (R;XA)
Introductory lectures on conformal field theory and strings, 15:33500 (R;XA)
Membranes, strings, extended elementary particles as singularities of fields, 15:33488 (R;XA)
Operator formalism of multi-pole Virasoro algebra on Riemann sphere, 15:33498 (R;XA)
"Topological" (Chern-Simons) quantum mechanics, 15:33515 (J;US)

QUANTUM GRAVITY
On the dimensional reduction of a gravitational theory containing higher-derivative terms, 15:33700 (R;XA)
Quantum gravity in two dimensions and the SL(2,R) current algebra, 15:33494 (R;XA)

QUANTUM MECHANICS
Dissipative quantum maps, 15:33672 (R;XA)
Elementary examples of adiabatic invariance, 15:33714 (J;US)
Old and new ideas in the theory of quantum measurement, 15:33683 (R;XA)
On a calculation of the ground-state energy in quantum mechanics, 15:33696 (R;XA)
Quantum chaos and dissipation: Lyapunov exponents, 15:33674 (R;XA)
"Topological" (Chern-Simons) quantum mechanics, 15:33515 (J;US)

QUANTUM NUMBERS
Baryon-symmetric baryogenesis, 15:33512 (J;US)

QUARK CONFINEMENT
See BAG MODEL

QUARK MATERIAL
See QUARK MATTER

QUARK MATTER
Prediction for mesonic spectrum from the discrete quark-gluon states of a finite size bag, 15:33442 (R;BR)

QUARK PLASMA
See QUARK MATTER

QUARK SEA
See QUARK MATTER

QUARK-GLUON PLASMA
See QUARK MATTER

QUARKONIUM
Heavy quarkonium production close to neutral gauge E_6 bosons in e^+e^- annihilation, 15:33435 (R;XA)

QUARKS
A summary of the results from LASS [Large Aperture Superconducting Solenoid] and the future of strange quake spectroscopy, 15:33410 (R;US)
Cancellation of infrared and mass singularities in the thermal dilepton rate, 15:33505 (R;FR)
Cut-off and effective meson field theory, 15:33431 (R;FR)
Higher-order corrections to the scalar quark density in the proton, 15:33457 (J;US)
Minimal dynamical symmetry breaking of the standard model, 15:33482 (J;US)
Quark masses and mixing angles from universal seesaw mechanism, 15:33458 (J;US)
Radiative decay of the bottom quark and the $WW\gamma$ coupling, 15:33438 (R;XA)
Recognizing the next heavy quark at $p\bar{p}$ colliders, 15:33452 (J;US)

QUARTZ
A time-resolved x-ray scattering technique for observation of non-equilibrium phonons, 15:32742 (J;US)
Morphological and biochemical investigations into the effects of quartz on bovine alveolar macrophages (BAM) and their organelles, 15:33232 (R;DE;In German)

R

R-1650 RESONANCES
See MESONS

RADIATION ACCIDENTS
Manual of protective actions for nuclear incidents, 15:32259 (R;US)

RADIATION BURDEN
See RADIATION DOSES

RADIATION CHEMISTRY
Interaction of ionizing radiation with matter, 15:32830 (BA;US)
Radiation Laboratory, University of Notre Dame quarterly report, January 1–March 31, 1990, 15:32829 (R;US)
Theoretical aspects of radiation chemistry, 15:32831 (BA;US)

RADIATION DAMAGE (BIOLOGICAL)
See RADIATION INJURIES

RADIATION DAMAGE (NONBIOLOGIC)
See RADIATION EFFECTS

RADIATION DETECTORS
See also NEUTRON DETECTORS
POSITION SENSITIVE DETECTORS
SHOWER COUNTERS
STREAK CAMERAS
X-ray detection using the quantum well exciton nonlinearity, 15:33789 (J;US)

RADIATION DOSES
An aerial radiological survey of the Evans Area, US Army Communications-Electronics Command, Fort Monmouth, New Jersey: Date of survey, November 1988, 15:33055 (R;US)

RADIATION EFFECTS
Thermal emission model for the anneal of radiation-induced trapped holes, 15:32985 (R;US)

RADIATION EXPOSURE (DOSES)
See RADIATION DOSES

RADIATION HYGIENE
See RADIATION PROTECTION

RADIATION INJURIES
Investigations on the detection and prevention of DNA-lesions induced by ionizing irradiation, 15:33220 (R;DE;In German)

RADIATION PROTECTION
Council for Nuclear Safety annual report 1988/89, 15:32256 (R;ZA;In English, Afrikaans)
Manual of protective actions for nuclear incidents, 15:32259 (R;US)
Proceeding of the symposium on the plan for establishment of Health Physics Research Center, 15:32254 (R;JP;In Japanese)

RADIATION PROTECTION LAWS
Annual report on the administration of the Radiation Control for Health and Safety Act of 1968, Public Law 90-602, (1988), April 1, 1989. Annual report, 15:33226 (R;US)

RADIATION SAFETY
See RADIATION PROTECTION

RADIATION SOURCES
See also LIGHT SOURCES
SEALED SOURCES
X-RAY SOURCES
Control system for the Neutron Therapy Facility at Fermilab, 15:32915 (BA;US)
Time-resolved solid-state array imaging system: Developments and applications, 15:32261 (BA;US)

RADICALS
See also ALKYL RADICALS
A general model of electron spin polarization arising from the interactions within radical pairs, 15:32818 (J;US)

RADIOACTIVE BIOLOGICAL WASTES
See RADIOACTIVE WASTES

RADIOACTIVE CLOUDS
Wind tunnel tests on the evaluation of interferences due to buildings on the propagation of radioactive materials after release from nuclear facilities. Report and annex, 15:33046 (R;DE;In German)

RADIOACTIVE EFFLUENTS
Radiological effluents released from announced US continental tests, 1961 through 1988, 15:33035 (R;US)

RADIOACTIVE GASEOUS WASTES
See GASEOUS WASTES
RADIOACTIVE WASTES
RADIOACTIVE MATERIALS
See also FISSION PRODUCTS
RADIOACTIVE WASTES
Hanford Environmental Dose Reconstruction Project: Monthly report, 15:33102 (R;US)
Pantex Plant site environmental report for calendar year 1988, 15:33062 (R;US)
Risks and nuclear insurance, 15:32368 (R;IT)
RADIOACTIVE PARTICULATES
See PARTICLES
RADIOACTIVE WASTE DISPOSAL
Effect of environmental materials on R7T7 nuclear waste glass alteration. Clay effect, 15:32201 (R;FR;In French)
Experiments on container materials for Swiss high-level waste disposal projects. Part IV, 15:32550 (R;CH)
FUETAP concrete, 15:32250 (BA;US)
Monazite, 15:32246 (BA;US)
Public understanding of radioactive waste management issues: Perspectives and the IAEA's role, 15:32251 (J;XA)
Sediment study - intermediate report 1988: disposal options for long lived radioactive waste in Swiss sedimentary formations: Executive summary, 15:32223 (R;CH)
RADIOACTIVE WASTE FACILITIES
See also WIPP
Buried waste program at the Idaho National Engineering Laboratory, 15:32249 (BA;US)
Field Lysimeter Test Facility: Second year (FY 1989) test results, 15:32228 (R;US)
Geohydrology of the 218-W-5 Burial Ground, 200-West Area, Hanford Site, 15:32231 (R;US)
Nuclear waste, 15:32220 (R;US)
Nuclear waste: Quaterly report as of March 21, 1989, 15:32219 (R;US)
Soil gas surveying at low-level radioactive waste sites, 15:32215 (R;US)
West Valley Demonstration Project annual report to Congress, 15:32243 (R;US)
RADIOACTIVE WASTE MANAGEMENT
Low-level radioactive waste management in the United States, 15:32252 (BA;US)
Public perception and acceptance of the siting of nuclear waste facilities in seven countries, 15:32218 (R;US)
RADIOACTIVE WASTE PROCESSING
Immobilization of technetium in blast furnace slag grouts, 15:32245 (BA;US)
Selection of immobilization technology for TRU [transuranic] waste, 15:32233 (R;US)
RADIOACTIVE WASTES
See also ALPHA-BEARING WASTES
HIGH-LEVEL RADIOACTIVE WASTES
LOW-LEVEL RADIOACTIVE WASTES
RADIOACTIVE EFFLUENTS
Control loop and unit operational realtime modeling on a Distributed Control System, 15:32242 (R;US)
Environmental restoration and waste management site-specific plan for the Richland Operations Office: Detailed information, 15:32210 (R;US)
Model based, sensor directed remediation of underground storage tanks, 15:32858 (R;US)
Prediction of glass durability as a function of environmental conditions, 15:32810 (BA;US)
Radiation effects in silicate glasses: A review, 15:32728 (BA;US)
Radionuclide uptake by pinetrees growing on lysimeters, 15:33123 (R;US)
Remedial Action Assessment System (RAAS): Evaluation of selected feasibility studies of CERCLA [Comprehensive Environmental Response, Compensation, and Liability Act] hazardous waste sites, 15:32229 (R;US)
Revised Eh-pH diagrams (25 C, one bar) for uranium and transuranic elements: Application to radioactive waste studies, 15:32809 (BA;US)
SST [single-shell tank] sample characterization analysis of archive samples 102-C, 105-C, and 106-C, 15:32230 (R;US)
WIPP/SRL [Waste Isolation Pilot Plant/Savannah River Laboratory] in-situ tests: MIIT [Materials Interface Interactions Tests] program—Glass/metal interfaces of SRS waste glass, 15:32241 (R;US)
RADIOAPPLICATORS
See RADIATION SOURCES
RADIOBIOLOGY
Theoretical aspects of radiation chemistry, 15:32831 (BA;US)
RADIOCARBON DATING
See CARBON 14
RADIOFREQUENCY SYSTEMS
See RF SYSTEMS
RADIOISOTOPE MIGRATION
See RADIONUCLIDE MIGRATION
RADIOISOTOPES
Hanford Waste Vitrification Plant Clean Air Act permit application, 15:32211 (R;US)
Inhalation Toxicology Research Institute annual report, October 1, 1987–September 30, 1988, 15:33223 (R;US)
Inhalation Toxicology Research Institute annual report, October 1, 1988–September 30, 1989, 15:33224 (R;US)
[Finalization of the International Biospheric Model Validation Study]: Foreign trip report, April 22, 1990–April 28, 1990, 15:33067 (R;US)
[Radiological protection of the public from intakes of radionuclides]: Foreign trip report, April 21, 1990–April 27, 1990, 15:33225 (R;US)
RADIOLOGICAL PROTECTION
See RADIATION PROTECTION
RADIOMETRIC GAGES
On-line monitor for metallic wear products. Phase 1. Final report, 15:32260 (R;US)
RADIONUCLIDE MIGRATION
Final report on the Project Research 'Assessment of Human Exposure to Environmental Radiation': April 1983 - March 1988, 15:33130 (R;JP;In Japanese)
Grimsel test site: laboratory investigations in support of the migration experiments, 15:32222 (R;CH)
Report on once-through column experiments with carbon-14, 15:32221 (R;DE;In German)
Transport studies of radon in limestone underlying houses, 15:33118 (R;US)
RADIONUCLIDE TRANSFER (IN ENVIRONMENT)
See RADIONUCLIDE MIGRATION
RADIONUCLIDES
See RADIOISOTOPES
RADIOSURGERY
See RADIOTHERAPY
RADIOTHERAPY
Control system for the Neutron Therapy Facility at Fermilab, 15:32915 (BA;US)
RADIUM 226
Multimedia assessment of health risks for the Weldon Spring site remedial action project, 15:32202 (R;US)
Radiological oversight and certification report for the Lansdowne property, 105-107 East Stratford Avenue, Lansdowne, Pennsylvania, August 1988–June 1989, 15:33114 (R;US)
Volume estimate of radium-contaminated soil in a section of Barrows Field Park, Glen Ridge, New Jersey, November–December 1989, 15:33115 (R;US)
RADIUM 228
Multimedia assessment of health risks for the Weldon Spring site remedial action project, 15:32202 (R;US)
RADON
A nation-wide survey of radon indoors and outdoors in Japan, 15:33064 (RA;JP;In Japanese)
Fiscal Year 1988 program report: Maine Environmental Studies Center, 15:32154 (R;US)
Meteorological factors influencing on the radon concentrations in indoor and outdoor airs, 15:33065 (RA;JP;In Japanese)
Radon and its progeny at the elevated areas in Japan, 15:33063 (RA;JP;In Japanese)

Summertime elevation of radon in southern Appalachian homes, 15:33049 (R;US)

RADON 220
Radon-222, ^{222}Rn progeny, and ^{220}Rn progeny levels in 70 houses, 15:33111 (J;US)

RADON 222
A unified theory of radon transport in porous media: Model benchmark and soil parameter evaluations: Project annual report, 15:33140 (R;US)
Factors affecting passive monitoring of radon, 15:33603 (R;JP)
First-phase study design for the US Navy Radon Assessment and Mitigation Program (NAVRAMP), 15:32481 (R;US)
Performance experience with radon mitigation systems, 15:32480 (R;US)
Radon-222, ^{222}Rn progeny, and ^{220}Rn progeny levels in 70 houses, 15:33111 (J;US)
Transport studies of radon in limestone underlying houses, 15:33118 (R;US)

RAMAN SPECTROSCOPY
In situ surface-enhanced Raman spectroscopy using new TiO2 based substrates, 15:32796 (BA;US)

RARE EARTH ALLOYS
See also ERBIUM ALLOYS
GADOLINIUM ALLOYS
YTTERBIUM ALLOYS
Minerals yearbook, 1988. Rare-earth minerals and metals, 15:32461 (R;US)
Radiation effects in magnetic and superconducting materials, 15:32665 (J;US)

RARE EARTH COMPOUNDS
See also GADOLINIUM COMPOUNDS
HOLMIUM COMPOUNDS
LANTHANUM COMPOUNDS
MONAZITES
Complex magnetic properties of the rare-earth copper oxides, R_2CuO_4, observed via measurements of the dc and ac magnetization, EPR, microwave magnetoabsorption, and specific heat, 15:32677 (J;US)

RARE EARTHS
See also CERIUM
EUROPIUM
GADOLINIUM
LANTHANUM
NEODYMIUM
SAMARIUM
YTTERBIUM
Bubble attachment time measurements for selected rare-earth phosphate minerals in oleate solutions, 15:32798 (BA;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 10. Primary and secondary germanium and gallium, primary rare earth metals, secondary indium. Index. Final report, 15:33162 (R;US)
Minerals yearbook, 1988. Rare-earth minerals and metals, 15:32461 (R;US)
Process variables in the preparation of high purity rare earth metals, 15:32799 (BA;US)
Solvent extraction equilibria of tervalent lanthanides: A systematic investigation of selectivity of chelate extraction, 15:32797 (BA;US)

RARE GASES
See also ARGON
HELIUM
KRYPTON
NEON
RADON
XENON
Demonstration of noble gas collection using the cryogenic technique, 15:33060 (R;US)

RDF
See REFUSE DERIVED FUELS

REACTOR ACCIDENTS
See also DESIGN BASIS ACCIDENTS
LOSS OF COOLANT
MELTDOWN
Living PRAs [probabilistic risk analysis] made easier with IRRAS [Integrated Reliability and Risk Analysis System], 15:32362 (R;US)
Melt propagation in dry core debris beds, 15:32426 (J;US)
Recriticality in a boiling water reactor following a core damage accident, 15:32404 (RA;US)

REACTOR CELLS
Solution of the multigroup transport equations for fuel element assemblies according to the first collision procedure, 15:32331 (R;DE;In German)

REACTOR COMPONENTS
See also BREEDING BLANKETS
FUEL ELEMENTS
REACTOR COOLING SYSTEMS
REACTOR CORES
Fault tree analysis of nuclear power plant components and systems. January 1976-December 1989 (a Bibliography from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for January 1976-December 1989, 15:32425 (R;US)
Guidelines for the procurement and receipt of items for nuclear power plants (NCIG-15): Final report, 15:32335 (R;US)
Life assessment procedures for major LWR components, 15:32407 (RA;US)
Mechanical damage experience in major light water reactor systems, 15:32364 (R;US)

REACTOR CONTROL SYSTEMS
Human factors survey of advanced instrumentation and controls, 15:32409 (RA;US)
Nuclear power applications of NASA control and diagnostics technology: Volume 1, Project results: Final report, 15:32341 (R;US)

REACTOR COOLING SYSTEMS
Assessment of TRAC-PF1/MOD1 Version 14.3 using separate effects critical flow and blowdown experiments: Volume 2, Figures, 15:32424 (R;US)
Assessment of TRAC-PF1/MOD1 version 14.3 using separate effects critical flow and blowdown experiments: Volume 1, Test and tables, 15:32423 (R;US)

REACTOR CORES
See also HETEROGENEOUS REACTOR CORES
Critical experiment tests of bowing and expansion reactivity calculations for liquid-metal-cooled fast reactors, 15:32428 (J;US)
Melt propagation in dry core debris beds, 15:32426 (J;US)
Recriticality in a boiling water reactor following a core damage accident, 15:32404 (RA;US)
Trends versus reactor size of passive reactivity shutdown and control performance, 15:32427 (J;US)

REACTOR DECOMMISSIONING
Determination of the long-lived nuclides in biological shielding concrete, ion exchange resin and fuel storage pool water of JPDR, 15:32371 (R;JP;In Japanese)
Nuclear regulation: NRC's decommissioning procedures and criteria need to be strengthened, 15:32349 (R;US)

REACTOR FUEL ELEMENTS
See FUEL ELEMENTS

REACTOR FUELS
See NUCLEAR FUELS

REACTOR LICENSING
Indexes to Nuclear Regulatory Commission issuances, July–December 1989: Volume 30, Index 2, 15:32328 (R;US)

REACTOR MATERIALS
See also NUCLEAR FUELS
A probabilistic approach to the evaluation of the PTS [pressurized thermal shock] issue, 15:32356 (R;US)

REACTOR MONITORING SYSTEMS
Nuclear power applications of NASA control and diagnostics technology: Volume 1, Project results: Final report, 15:32341 (R;US)

Nuclear power applications of NASA control and diagnostics technology: Volume 3, Users manual: Final report, 15:32343 (R;US)

REACTOR OPERATORS
The effects of local control station design variation on plant risk, 15:32410 (RA;US)

REACTOR PHYSICS
Delayed neutron data and group parameters for 43 fissioning systems, 15:32334 (J;US)

REACTOR SAFETY
Nuclear engineering research opportunities at Brookhaven National Laboratories, 15:32462 (R;US)
Review of overall safety manual for space nuclear systems: An evaluation of a nuclear safety analysis methodology for plutonium-fueled space nuclear systems, 15:32357 (R;US)

REACTOR SAFETY EXPERIMENTS
3.5% cold leg break test without hydroaccumulator application: Computerized measurement analysis, 15:32375 (R;HU;In Hungarian)

REACTOR SHUTDOWN
Trends versus reactor size of passive reactivity shutdown and control performance, 15:32427 (J;US)

REACTOR START-UP
Nuclear regulation: NRC's restart actions appear reasonable-but criteria needed, 15:32365 (R;US)

REACTOR VESSELS
Heavy-section steel technology program - Fracture issues, 15:32405 (RA;US)
Power reactor embrittlement data base, 15:32551 (RA;US)
Prediction of the brittle-ductile transition temperature shift, from irradiation experiments obtained in France, 15:32533 (R;FR;In French)

REACTORS
See also POWER REACTORS
PROCESS HEAT REACTORS
PRODUCTION REACTORS
WATER COOLED REACTORS
[International conference on the physics of reactors]: Foreign trip report, April 20, 1990–May 6, 1990, 15:32332 (R;US)

RECOMBINANT DNA
Recombinant dna technical bulletin. Volume 12, Number 3, September 1989, 15:32280 (R;US)

REDUCTASES
See OXIDOREDUCTASES

REFERENCE MATERIALS (STANDARD)
See CALIBRATION STANDARDS

REFRACTORIES
Spherical pinch discharges for elemental analysis, 15:32790 (BA;US)

REFRACTORY METALS
Cathode erosion rates in vacuum-arc discharges–, 15:33831 (J;US)

REFRIGERANTS
Initial parametric results using CYCLEZ—An LMTD-specified, Lorenz-Meutzner cycle refrigerator-freezer model, 15:32503 (R;US)
Thermodynamic calculations for mixtures of environmentally safe refrigerants using the Lee-Kesler-Ploecker equation of state, 15:32701 (R;US)

REFRIGERATION
Cryogenic refrigeration. March 1982-March 1990 (A Bibliography from the NTIS data base). Report for March 1982-March 1990, 15:32854 (R;US)
Study of a magnetic refrigeration cycle by active regeneration between 15 and 4.2 kelvins, 15:32864 (R;FR;In French)

REFUELING WATER SYSTEMS
See AUXILIARY WATER SYSTEMS

REFUSE
See SOLID WASTES

REFUSE DERIVED FUELS
Results of emissions and ash testing in full-scale co-combustion tests of binder-enhanced dRDF pellets and high-sulfur coal, 15:32513 (R;US)

REGION X
See FEDERAL REGION X

REGULATIONS
See also POLLUTION REGULATIONS
Environmental restoration and waste management site-specific plan for the Richland Operations Office: Detailed information, 15:32210 (R;US)
Monitored Retrievable Storage facility site screening and evaluation report: Volume 3, 15:32208 (R;US)
Monitored retrievable storage facility site screening and evaluation report: Volume 1, 15:32206 (R;US)
Monitored retrievable storage facility site screening and evaluation report: Volume 2, 15:32207 (R;US)
The environmental compliance process at New York FUSRAP [Formerly Utilized Sites Remedial Action Program] sites, 15:32253 (R;US)
Tiger Team assessment of the Pinellas Plant, 15:33121 (R;US)
Tiger Team environment, safety, and health assessment of the Kansas City Plant, 15:33120 (R;US)

REINFORCED MATERIALS
Friction and wear of whisker-reinforced ceramic composite bodies, 15:32609 (R;US)

RELATIVISTIC BEAM INJECTION
Simulation of relativistic electron and ion flows, 15:33339 (RA;CS)

RELATIVISTIC PLASMA
Inclusive results at 90^0, at I.S.R., favourable to a diquark understructure of the proton, and estimations of quantum chromodynamics, 15:33409 (R;FR;In French)

RELATIVITY THEORY
Does nature place a fundamental limit on strength?, 15:33695 (R;XA)

RELEASE (FISSION PRODUCT)
See FISSION PRODUCT RELEASE

REMEDIAL ACTION
Environmental restoration and waste management site-specific plan for the Richland Operations Office: Detailed information, 15:32210 (R;US)
Remedial Action Assessment System (RAAS): Evaluation of selected feasibility studies of CERCLA [Comprehensive Environmental Response, Compensation, and Liability Act] hazardous waste sites, 15:32229 (R;US)
The environmental compliance process at New York FUSRAP [Formerly Utilized Sites Remedial Action Program] sites, 15:32253 (R;US)

RENEWABLE ENERGY SOURCES
See also BIOMASS
HYDROELECTRIC POWER
SOLAR ENERGY
WIND POWER
Renewable energy research and development workshop, 15:32472 (R;CA)
Repercussion of the production of renewable resources on foodstuff supply and appraisal of policy measures for promoting the production of renewable resources, 15:32268 (R;DE;In German)

RENEWABLE RESOURCES
Hawaii Natural Energy Institute: 1989 Annual report, 15:32452 (R;US)
Renewable-resource management in agriculture. World Bank operations evaluation study, 15:32455 (R;US)

REPAIR (BIOLOGICAL)
See BIOLOGICAL REPAIR

RESEARCH PROGRAMS
Energy and Technology Review, March 1990, 15:32529 (R;US)
FAO/IAEA research and training in soil fertility at the IAEA's Seibersdorf Laboratories, 15:33839 (J;XA)

RESERVES
See also NAVAL PETROLEUM RESERVE
STRATEGIC PETROLEUM RESERVE
Economics of nonrenewable energy resources, 15:32453 (R;US)

RESERVOIR ROCK
A comparison of pressure-transient and tracer-concentration/time data for layered reservoirs under injection, 15:32134 (J;US)

A perfluorocarbon tracer transport and dispersion experiment in the North Sea Ekofisk oil field: Revision, 15:33116 (R;US)
Ground movements associated with gas hydrate production in geologic media: Final report, 15:32172 (R;US)
Three-dimensional permeability and fluid flow, 15:32131 (R;NO)

RESID
See PETROLEUM RESIDUES

RESIDENCES
See HOUSES

RESIDENTIAL BUILDINGS
See also APARTMENT BUILDINGS
HOUSES
Radiological oversight and certification report for the Lansdowne property, 105-107 East Stratford Avenue, Lansdowne, Pennsylvania, August 1988–June 1989, 15:33114 (R;US)
Transport studies of radon in limestone underlying houses, 15:33118 (R;US)

RESIDUAL OILS
See PETROLEUM RESIDUES

RESIDUES
See also ASHES
[A small-scale study of Rocky Flats uncalcined incinerator ash dissolution and filtrate anion exchange]: Draft, 15:32234 (R;US)

RESIDUES (RADIOACTIVE)
See RADIOACTIVE WASTES

RESINS
Determination of airborne organics by direct sampling mass spectrometry, 15:33050 (R;US)
Improvements in macroreticular particles for ion-exchange and gel-permeation chromatography, 15:32700 (R;US)
Polymer-based separations: Synthesis and application of polymers for ionic and molecular recognition: Annual performance report, August 1, 1989–July 31, 1990, 15:32702 (R;US)

RESISTIVITY (ELECTRIC)
See ELECTRIC CONDUCTIVITY

RESONANCE CAVITIES
See CAVITY RESONATORS

RESOURCE CONSERVATION
Conservation Reserve Program: An economic assessment. Agricultural economic report, 15:32457 (R;US)

RESOURCE DEVELOPMENT
Sustainable development, 15:32451 (R;NO)

RESOURCE MANAGEMENT
International decision making and global climate change: Lessons of prior resource management efforts for consensus building, 15:33053 (R;US)

RESOURCE RECOVERY ACTS
Federal-facilities Hazardous-Waste Compliance Manual. Final report, 15:32447 (R;US)
Resource Conservation and Recovery Act (RCRA): Hazardous wastes. August 1978-March 1990 (A Bibliography from the NTIS data base). Report for August 1978-March 1990, 15:32510 (R;US)

RESOURCES
See also RENEWABLE RESOURCES
RESERVES
WATER RESOURCES
Economics of nonrenewable energy resources, 15:32453 (R;US)

RESPIRABLE DUSTS
See DUSTS

RESTAURANTS
Energy requirements in Canadian restaurants: Final report, 15:32485 (R;CA)

RETORTED SHALES
See SPENT SHALES

REVERSE-FIELD PINCH
Simulation study of self-organization and self-relaxation processes in plasma, 15:33738 (R;JP)
The Madison Symmetric Torus, 15:33810 (R;US)

REWETTING
Sensitivity analyses on reflooding effect on the TMI-2 accident by the SCDAP code, 15:32369 (R;JP;In Japanese)

RF SYSTEMS
Digital control of the LEP RF system, 15:32963 (BA;US)
Status of superconducting RF cavity development, 15:32951 (BA;US)
System coupling and effects optimization, 15:32886 (R;US)
Upgrading of TRISTAN by superconducting RF system, 15:32964 (BA;US)

RHENIUM
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 6. Primary tungsten, secondary tungsten and cobalt, primary molybdenum and rhenium, secondary molybdenum and vanadium. Final report, 15:33159 (R;US)

RHENIUM SILICIDES
Effect of transition-metal substitutions on competing electronic transitions in the heavy-electron compound URu_2Si_2, 15:32761 (J;US)

RHO-1500 RESONANCES
See MESONS

RHO-1700 RESONANCES
See MESONS

RHODIUM 96
High-spin structure of N=51 ^{96}Rh and ^{97}Pd: A shell-model study, 15:33548 (J;US)

RHODIUM SILICIDES
Effect of transition-metal substitutions on competing electronic transitions in the heavy-electron compound URu_2Si_2, 15:32761 (J;US)

RIEMANN CURVATURE TENSOR
See RIEMANN SPACE

RIEMANN GEOMETRY
See RIEMANN SPACE

RIEMANN MANIFOLDS
See RIEMANN SPACE

RIEMANN METRIC
See RIEMANN SPACE

RIEMANN SPACE
A corollary to Kodaira-Spencer's theorem on continuity of eigenvalues, 15:33692 (R;XA)
Dirac's equation as a geodesic in Riemann space, 15:33664 (R;BR)
On an isospectrality question over compact Riemann surfaces, 15:33691 (R;XA)
Operator formalism of multi-pole Virasoro algebra on Riemann sphere, 15:33498 (R;XA)

RIEMANN SPHERE
See RIEMANN SPACE

RIEMANN WAVES
See SHOCK WAVES

RISER CRACKING
See COAL LIQUEFACTION

RISK ANALYSIS
See RISK ASSESSMENT

RISK ASSESSMENT
PRAMIS: Probability Risk Assessment Model Integration System: User's guide, 15:32418 (R;US)

RIVERS
See also POTOMAC RIVER
Survey and assessment of radioactivity level in Yangtze River water system, 15:33599 (R;CN;In Chinese)

ROADS
Traffic congestion: Federal efforts to improve mobility, 15:32493 (R;US)
Traffic congestion: Trends, measures, and effects, 15:32492 (R;US)

ROBOTS
DOE requirements for the next generation controller, 15:33038 (R;US)
Experimentation and concept formation by an autonomous mobile robot, 15:32843 (R;US)
Performance of multiple tasks by an autonomous robot using visual and ultrasound sensing, 15:32845 (R;US)
Sensor-based automated docking of large payloads, 15:32857 (R;US)
Time optimal trajectories for a two wheeled robot, 15:32853 (R;US)

Ultrasound and visual sensor feedback and fusion, 15:32844 (R;US)

ROCK BEDS
FRAC-UNIX theory and user's manual, 15:32298 (R;US)

ROCK MECHANICS
Grimsel test site: engineering geological investigations into the interpretation of rock stress measurements and fracture system flow tests, 15:32224 (R;CH;In German)

ROCKET ENGINES
A transformer coupled semiconductor bridge igniter for low voltage ignition from a high voltage source, 15:33025 (R;US)

ROCKS
^{10}Be profiles in lunar surface rock 68815, 15:33316 (BA;US)
Analysis of explosions in hard rocks: The power of discrete element modeling, 15:33039 (R;US)
Grimsel Test Site: heat test, final report, 15:32225 (R;CH;In German)
Grimsel test site: geology, 15:33267 (R;CH;In German)
Hydrologic modelling of the migration site at the Grimsel test site - the steady state, 15:33275 (R;CH)
Radar investigations at the Saltsjoetunnel - predictions and validation, 15:32238 (R;SE)
Rock motion simulation and prediction of porosity distribution for a two-void-level retort, 15:32184 (R;US)
Rock stress investigations, 15:33274 (R;CH;In German)
Strategic Petroleum Reserve Program: Salt dome geology and cavern stability analysis, Bayou Choctaw, Louisiana: Final report, Appendix, 15:32160 (R;US)

ROCKY FLATS PLANT
An aerial radiological survey of the United States Department of Energy's Rocky Flats Plant, Golden, Colorado: Date of survey, July 1989, 15:33057 (R;US)
Interaction of objects in manufacturing process simulation, 15:32852 (R;US)

RODS (FUEL)
See FUEL RODS

ROOFS
Insulating coatings (excluding electrical insulation). January 1980-November 1989 (A Bibliography from World Surface Coatings Abstracts). Report for January 1980-November 1989, 15:32487 (R;US)

RUBIDIUM 86
Possibility of rubidium-86 as a tracer of potassium and its application in agriculture as a tracer, 15:33217 (R;CN;In Chinese)

RUTHENIUM
Core-level photoemission from alkali metals on Ru(001), 15:32594 (J;US)
Evaluation of mixed alcohol production processes and catalysts, 15:32273 (R;US)

RUTHENIUM ALLOYS
Mechanism of achieving nanocrystalline AlRu by ball milling, 15:32566 (BA;US)

RUTHENIUM SILICIDES
Effect of transition-metal substitutions on competing electronic transitions in the heavy-electron compound URu_2Si_2, 15:32761 (J;US)

RYDBERG STATES
1/n-expansion and scaling for the Stark effect in Rydberg atoms, 15:33334 (R;XA)

S

S CODES
δ^2 – $Y_2Si_2O_7$ structure confirmed by processing and simulaton of atomic-resolution images, 15:32636 (BA;US)

S WAVES (SEISMIC)
See SEISMIC S WAVES

S-1000 RESONANCES
See MESONS

SAFETY
See also REACTOR SAFETY
North Slope investigation report, 15:33135 (R;US)

SAFETY (NUCLEAR)
See RADIATION PROTECTION

SAFETY (REACTOR)
See REACTOR SAFETY

SALINE ZONE
See OIL SHALES

SALT CAVERNS
SPR conceptual design: Supplement to salt dome geology and cavern stability analysis, Bayou Choctaw, Louisiana: Department of Energy Strategic Petroleum Reserve Program, Bayou Choctaw, Louisiana, 15:32123 (R;US)
Strategic Petroleum Reserve Program: Salt dome geology and cavern stability analysis, Bayou Choctaw, Louisiana: Final report, Appendix, 15:32160 (R;US)

SALTON SEA
Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the Salton Sea Area, California, 1986-87. Water-Resources investigation, 15:33164 (R;US)

SALTS
Importance of weak hydrogen bonding C-H–donor and C-H–anion interactions in governing the structural properties of organic donors BEDT-TTF and BEDO-TTF and their charge-transfer salts, 15:32803 (R;US)

SAMARIUM
Anomalous copper diffusion through samarium, 15:32751 (J;US)
Electron spectroscopic investigation of atomic 4d giant resonances for Ba, La and lanthanides, 15:33331 (R;DE;In German)

SAMARIUM 154 REACTIONS
Low-energy reactions with heavy deformed nuclei, 15:33590 (J;US)

SAMARIUM 154 TARGET
Low-energy reactions with heavy deformed nuclei, 15:33590 (J;US)

SAMARIUM OXIDES
Magnetism, specific heat, and pressure-dependent reistivity of the electron-doped compounds LnMCuO(Ln = Pr,Nd,Sm,Eu,Gd:M = Ce,Th), 15:32641 (BA;US)
Upper critical field of a $Sm_{1.85}Ce_{0.15}CuO_{4-y}$ single crystal: Interaction between superconductivity and antiferromagnetic order in copper oxides, 15:32670 (J;US)

SAMPLE HOLDERS
A cell for extended x-ray absorption fine structure studies of oxygen sensitive products of redox reactions, 15:32984 (J;US)

SAND
Parameters influencing porosity in sands and sandstones, 15:32125 (R;NO)

SANDIA LABORATORIES
Aerosol Dynamics Laboratory, 15:33000 (R;US)
Coal Combustion Science quarterly progress report, January–March 1990, 15:32118 (R;US)
Primary Standards Laboratory report: 2nd half 1989, 15:32965 (R;US)
Sandia National Laboratories data engineering for DOE production agencies, 15:33863 (R;US)

SANDSTONES
A comparison of relative permeability from centrifuging versus coreflooding, 15:32129 (R;US)
Parameters influencing porosity in sands and sandstones, 15:32125 (R;NO)
Permeability patterns in some fluvial sandstones: An outcrop study from Yorkshire, North East England, 15:32124 (R;NO)

SANITARY LANDFILLS
Economic impact study of landfill regulations (R88-7). Final report, 15:33165 (R;US)

SARA CYCLOTRON
News developments at Sara, 15:32908 (R;FR)

SARCOMAS
NIOSH (National Institute for Occupational Safety and Health) testimony on dioxin by J. D. Millar on November 9, 1983, 15:33238 (R;US)

SATELLITES
See also MOON

A new technique for hardening optically-triggered thyristors, 15:33043 (R;US)
Predicting switched-bias response from steady-state irradiations, 15:33042 (R;US)
Using the XPATHS computer code, 15:32855 (R;US)

SAVANNAH RIVER PLANT
Analytical Data Management System (ADMS), 15:33859 (R;US)
Effect of rib on burnout heat flux, 15:32339 (R;US)
Program for low-level radiactive waste disposal at the Savannah River Site, a U.S. nuclear materials production facility, 15:32248 (BA;US)
Savannah River Waste Management Program Plan, FY 1990, 15:32212 (R;US)

SCANDIUM ADDITIONS
Structure maps and phase stability in $AlTi_3$ alloyed with rare-earth elements, 15:32562 (BA;US)

SCANDIUM HYDRIDES
Hydrogen vibrational modes and anisotropic potential in α-ScH_x, 15:32682 (J;US)

SCATTERING
Strong coupling analogue of the Born series, 15:33707 (R;HU)

SCATTERING AMPLITUDES
About rainbow scattering in the presence of absorption, 15:33338 (R;FR)

SCENEDESMUS
Mechanisms of ^{60}Co uptake and loss by Scenedesmus obliquus and transfer to two benthic organisms, 15:33138 (R;FR;In French)

SCHROEDINGER EQUATION
Analytic solution of the two-state problem, 15:33718 (J;US)

SCOTLAND
See UNITED KINGDOM

SCRAP METALS
Recycling metal scrap. June 1970-January 1990 (A Bibliography from the COMPENDEX database). Report for June 1970-January 1990, 15:32509 (R;US)

SEA LEVEL
Potential Effects of Global Climate Change on the United States. Appendix B. Sea-level rise. Report to the Congress, 15:33070 (R;US)

SEACOAST
See SHORES

SEALED SOURCES
Standard operational radiation protection instructions for process instrumentation and control engineering applying radiometric equipment containing sealed sources, 15:33605 (R;DD;In German)

SEAS
Dispersion relations for gravity waves in a deep fluid: Second sound in a stormy sea, 15:33395 (J;US)
Identification of oscillations in Ross Sea current data, 15:33280 (J;US)

SEASONAL THERMAL ENERGY STORAGE
Simulation of thermal conditions in a solar heating system with seasonal storage, 15:32293 (R;DK;In Danish)

SEAWATER
Concentrations of metals in Norton Sound seawater samples and human hair samples, 1989, 15:33188 (R;US)

SECONDARY RECOVERY
See ENHANCED RECOVERY

SECURITY
Counterintelligence and operations security-support program for the Defense Nuclear Agency. Directive, 15:33020 (R;US)

SEDIMENTS
Analysis of mutagenic activity of biohazardous organics in Kanawha River sediments. Technical completion report, 15:33181 (R;US)
Concentrations of metals in Norton Sound seawater samples and human hair samples, 1989, 15:33188 (R;US)
Dechlorination of pentachlorophenol, 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid in anaerobic freshwater sediments, 15:33148 (R;US)
Determination of heavy metals on the Rock River through the analysis of sediments, 15:33145 (R;US)
Polychlorinated biphenyls: Occurrence in sediments and soils. January 1977-March 1990 (A Bibliography from the Selected Water Resources Abstracts data base). Report for January 1977-March 1990, 15:33187 (R;US)
Sediment-water interactions and their effects upon water quality. January 1979-March 1990 (A Bibliography from the NTIS data base). Report for January 1979-March 1990, 15:33186 (R;US)
Subduction zone tectonic studies to develop concepts for the occurrence of sediment subduction (Phase 2): Volume 2: Final report, 15:32169 (R;US)
Subduction zone tectonic studies to develop concepts for the occurrence of sediment subduction (Phase 2): Volume 1: Final report, 15:32168 (R;US)
Subduction zone tectonic studies to develop concepts for the occurrence of sediment subduction (Phase 2): Volume 3: Final report, 15:32170 (R;US)
Superfund Record of Decision (EPA Region 6): Motco Superfund Site, La Marque, Texas (second remedial action), September 1989. Final report, 15:33146 (R;US)

SEEDLINGS
Dependence of the phototropic response of Arabidopsis thaliana on fluence rate and wavelength, 15:33206 (J;US)

SEISMIC EFFECTS
SDA/LARS™ final report: Development and verification of a learning and recognition system (LARStrademark) for seismic data analysis (SDA), 15:33001 (R;US)
SONATINA-2H: a computer program for seismic analysis of the two-dimensional horizontal slice HTGR core, 15:32324 (R;JP)

SEISMIC EVENTS
See also EARTHQUAKES
Seismic uplift of nuclear containments, 15:32386 (RA;US)

SEISMIC P WAVES
Acoustic and elastic diffraction tomography and its application to fracture detection, 15:33262 (R;US)

SEISMIC S WAVES
Acoustic and elastic diffraction tomography and its application to fracture detection, 15:33262 (R;US)

SELENIUM
Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the Salton Sea Area, California, 1986-87. Water-Resources investigation, 15:33164 (R;US)

SELENIUM HYDRIDES
Theoretical study of GeH_n, AsH_n, and SeH_n: Ionization energies, 15:33384 (J;US)

SELENIUM IONS
Correlation enhancement of the electron-impact ionization cross section for excited-state Ne-like ions, 15:33370 (J;US)

SELF-CONSISTENT FIELD
A consistent analysis for the quark condensate $<\phi\,\phi>$ in QCD, 15:33432 (R;CN)

SEMICONDUCTOR DEVICES
See also SEMICONDUCTOR DIODES
THYRISTORS
TRANSISTORS
Center for Electronics and Electrical Engineering Technical Progress Bulletin covering Center programs, July to September 1989, with 1990 CEEE events calendar, 15:32466 (R;US)
Development of a point-contact solar cell using high-volume processing techniques: Final report, 15:32284 (R;US)
Multichip packaging technology with laser-patterned interconnects, 15:32714 (R;US)

SEMICONDUCTOR DIODES
See also PHOTODIODES
Measurements of 1/f noise in A-Si:H pin diodes and thin-film-transistors, 15:32977 (R;US)
Performance measurements of hybrid PIN diode arrays, 15:32938 (R;US)

SEMICONDUCTOR JUNCTIONS
Electrical and structural properties of $TiSi_2$ films, 15:32737 (BA;US)
Electrochemical characterization of bilayer lipid membrane-semiconductor junctions, 15:32763 (J;US)

Evidence that similar point defects cause 1/f noise and radiation-induced-hole trapping in metal-oxide-semiconductor transistors, 15:32749 (J;US)
Metal silicides formed by direct ion beam deposition, 15:32627 (BA;US)

SEMICONDUCTOR MATERIALS
See also N-TYPE CONDUCTORS
Atomic scale imaging of the structure and chemistry of semiconductor interfaces, 15:32698 (R;US)
Center for Electronics and Electrical Engineering Technical Progress Bulletin covering Center programs, July to September 1989, with 1990 CEEE events calendar, 15:32466 (R;US)
Critical phenomena in nanoscale multilayer materials, 15:32565 (BA;US)
Effect of retardation on the reflectance properties of the metallic Fibonacci quasi-superlattice, 15:33623 (R;XA)
Electronic modes and infrared optical excitation in tunneling superlattices, 15:33651 (J;US)
New real space correlated-basis-functions approach for the electron correlations of the semiconductor inversion layer, 15:33622 (R;XA)
Reply to "Comment on 'Existence of Wannier-Stark localization' ", 15:33647 (J;US)
Structural and chemical imaging of superconductors and semiconductors by high-resolution STEM, 15:32719 (BA;US)
The growth of high quality CdTe on GaAs by molecular beam epitaxy, 15:32754 (J;US)

SERVICE WATER SYSTEMS
See AUXILIARY WATER SYSTEMS

SEWAGE SLUDGE
Sludge dewatering: Sewage and industrial wastes. January 1978-December 1989 (A Bibliography from Pollution Abstracts). Report for January 1978-December 1989, 15:33133 (R;US)

SEX CHROMOSOMES
See HETEROCHROMOSOMES

SHAFT EXCAVATIONS
Geomechanical analyses in support of the Waste Isolation Pilot Plant (WIPP), 15:32237 (R;US)

SHALE OIL
Western states enhanced oil shale recovery program: Shale oil production facilities conceptual design studies report, 15:32185 (R;US)

SHALES
Derivative spectrophotometry of metalloporphyrins from shale, 15:32187 (BA;US)

SHAPED CHARGES
Modeling jet penetration in glass, 15:33033 (R;US)

SHEAR WAVES (SEISMIC)
See SEISMIC S WAVES

SHEATHS (FUEL)
See FUEL CANS

SHEILA HELIAC
Configurational effects on plasma confinement in SHEILA, 15:33724 (RA;AU)
ECH experiments in SHEILA, 15:33725 (RA;AU)
Electron beam measurements in SHEILA using a simple method of image intensification, 15:33727 (RA;AU)
Experimental studies on drift waves in SHEILA, 15:33729 (RA;AU)
Papers presented at seventh international workshop on stellarators, 15:33802 (R;AU)

SHELLS (CONTAINMENT)
See CONTAINMENT SHELLS

SHIELDING
QADS: A multidimensional point kernel analysis module, 15:33596 (R;US)

SHIFT PROCESSES
Low-temperature, sulfur-tolerant homogeneous catalysts for the water-gas shift reaction: Final report, 15:32050 (R;US)

SHIP PROPULSION REACTORS
Advanced marine reactor: Discussion of a soaking the reactor vessel in the water containment vessel upon the trial studies, 15:32327 (R;JP;In Japanese)

SHIPPINGPORT PRESSURIZED WATER REACTOR
See SHIPPINGPORT REACTOR

SHIPPINGPORT REACTOR
Embrittlement of the Shippingport reactor neutron shield tank, 15:32321 (R;US)

SHOCK (IMPACT)
See IMPACT SHOCK

SHOCK WAVES
A comparison of CTH predictions with experimental armor/anti-armor data for long rod penetrators in two and three dimensions, 15:32873 (R;US)
Turbulent energy at accelerating and shocked interfaces, 15:33390 (J;US)

SHORES
The coast guard's cleanup of hazardous waste sites, 15:33126 (R;US)

SHOWER COUNTERS
Rad-hard electronics development program for SSC liquid-argon calorimeters, 15:32966 (R;US)
Radiation tolerance implications for the mechanical design of a scintillator calorimeter for the SSC, 15:32967 (R;US)

SHRUBS
Evapotranspiration studies for protective barriers: FY 1988 status report, 15:32227 (R;US)

SHUTDOWN (REACTOR)
See REACTOR SHUTDOWN

SIALON
See ALUMINIUM OXIDES
SILICON NITRIDES

SID
See SUDDEN IONOSPHERIC DISTURBANCE

SIGMA MODEL
Non-linear σ-models and string theories, 15:33511 (BA;US)

SIGMA-410 RESONANCES
See SIGMA MODEL

SILANES
A numerical study of silane combustion, 15:32836 (R;US)

SILICA
Correlation between optical absorption and refractive index of silica and silicate glasses implanted with copper, 15:32723 (BA;US)
Evidence that similar point defects cause 1/f noise and radiation-induced-hole trapping in metal-oxide-semiconductor transistors, 15:32749 (J;US)
Polymers, fractals, and ceramic materials, 15:32671 (J;US)

SILICATES
See also ALUMINIUM SILICATES
Radiation effects in silicate glasses: A review, 15:32728 (BA;US)

SILICEOUS ROCK
See SANDSTONES

SILICON
Acidification
Chemisorption of HF on silicon surfaces, 15:32720 (BA;US)
Atom Collisions
The ionization of thermal and hyperthermal beams of Na, K, and Cs on Si(111) surfaces, 15:33646 (J;US)
Atom Transport
Metal silicides formed by direct ion beam deposition, 15:32627 (BA;US)
Chemical Bonds
Chemical bonding and lattice mismatch in semiconductor-insulator heteroepitaxy: SrFsub 2on Si(111), 15:32736 (BA;US)
Crystal Structure
Comment on "Observation and structural determination of $\sqrt{3}\times\sqrt{3}$ $R30°$ reconstruction of the Si(111) surface", 15:32747 (J;US)
Electrical Properties
Electronic properties of Si-Ge micro nipi structures, 15:32741 (BA;US)
Fabrication
Defect reduction in MOCVD grown Si/GaAs, 15:32724 (BA;US)
GaP/Si heteroepitaxial layers with reduced defect density, 15:32733 (BA;US)

The influence of thickness and wavelength on the mechanical properties of a compositionally modulated ceramic thin film, 15:32628 (BA;US)
The photoluminescence and TEM studies of patterned GaAs films on Si substrate grown by molecular beam epitaxy, 15:32729 (BA;US)

Film Condensation
Molecular-dynamics simulation of amorphous and epitaxial Si film growth on Si(111), 15:32773 (J;US)

Ionic Conductivity
Damage formation in semiconductors during MeV ion implantation, 15:32740 (BA;US)

Irradiation
Bipolar transistor fabrication using gas immersion laser doping, 15:32895 (BA;US)
Decay kinetics study of atomic hydrogen in a-Si:(H,O,N) and natural beryl, 15:33335 (R;BR)

Metastable States
Metastability in SiGe/Si strained-layer structures, 15:32738 (BA;US)

Nitridation
Kinetic and x-ray photoelectron spectroscopic studies of the thermal nitridation of Si (100), 15:32800 (BA;US)

Optical Properties
Two-channel polarization modulation ellipsometer, 15:32998 (J;US)

Oxidation
Composition and structure of native oxide on silicon by high resolution analytical electron microscopy, 15:32745 (J;US)

Photoconductivity
The hydrogenated amorphous silicon reach-through avalanche photodiodes (a-Si:H RAPD's), 15:32744 (J;US)

Physical Radiation Effects
An examination of the 1-MeV equivalent silicon damage methodology, 15:32557 (R;US)
Structural characterization of damage in Si(100) produced by MeV Si^+ ion implantation and annealing, 15:32746 (J;US)

Reaction Kinetics
Decay kinetics study of atomic hydrogen in a-Si:(H,O,N) and natural beryl, 15:33335 (R;BR)

Solvent Properties
Hydrogen dissolution in and release from nonmetals. II. Crystalline silicon, 15:32771 (J;US)

Space Charge
Surface space-charge dynamics and surface recombination on silicon (111) surfaces measured with combined laser and synchrotron radiation, 15:32756 (J;US)

Substrates
Epitaxial growth of diamond films on Si(111) at room temperature by mass-selected low-energy C^+ beams, 15:32672 (J;US)

Superlattices
Structural and chemical imaging of superconductors and semiconductors by high-resolution STEM, 15:32719 (BA;US)

SILICON 28 REACTIONS
Energy dependence of fusion evaporation-residue cross sections in the $^{28}Si+^{28}Si$ reaction, 15:33534 (J;US)

SILICON 28 TARGET
Energy dependence of fusion evaporation-residue cross sections in the $^{28}Si+^{28}Si$ reaction, 15:33534 (J;US)

SILICON CARBIDES
A particle-level numerical simulation of the dynamic consolidation of a metal matrix composite material, 15:32612 (R;US)
Acoustical and dynamic mechanical characterization of fiber-matrix interface bonds in ceramic composites, 15:32066 (R;US)
Cyclic damage zones ahead of tensile fatigue cracks in ceramic materials, 15:32608 (R;US)
Development of nondestructive evaluation methods and prediction of effects of flaws on the fracture behavior of structural ceramics, 15:32112 (R;US)
Electron microscopy of interfaces in silicon carbide whisker-reinforced alumina composites, 15:32699 (R;US)
Fatigue crack growth in ceramic materials at ambient and elevated temperatures, 15:32610 (R;US)
Friction and wear of whisker-reinforced ceramic composite bodies, 15:32609 (R;US)
Mechanical property characterization of fiber-reinforced SiC matrix composites, 15:32071 (R;US)
Metal matrix composites from dynamic consolidation of powder mixtures, 15:32544 (R;US)
Reinforcement/matrix interaction in SiC fiber-reinforced Ni_3Al matrix composites, 15:32582 (BA;US)
The chevron-notched bend bar technique for fracture resistance measurements of ceramics, 15:32652 (BA;US)

SILICON HYDRIDES
See SILANES

SILICON IONS
Experimental determination of a species-dependent effect in the transverse emittances of sputter-generated negative-ion beams, 15:33640 (J;US)

SILICON NITRIDES
Catalytic oxidation of silicon nitride thin films using potassium, 15:32639 (BA;US)
Ceramic port shields cast in an iron engine head, 15:32522 (J;US)
Ceramic valve development for heavy-duty low heat rejection diesel engines, 15:32521 (J;US)
Development of nondestructive evaluation methods and prediction of effects of flaws on the fracture behavior of structural ceramics, 15:32112 (R;US)
Friction and wear of whisker-reinforced ceramic composite bodies, 15:32609 (R;US)
Microencapsulation of silicon nitride particles with yttria and yttria-alumina precursors, 15:32668 (J;US)
Microwave processing of silicon nitride, 15:32605 (R;US)

SILICON OXIDES
See also QUARTZ
SILICA
Properties of films prepared from low surface area/density alumina-silica, 15:32615 (R;US)

SILICON SOLAR CELLS
Development of a point-contact solar cell using high-volume processing techniques: Final report, 15:32284 (R;US)

SILVER
Abrupt interfaces with novel structural and electronic properties: Metal-cluster deposition and metal-semiconductor junctions, 15:32600 (J;US)
Ambient-temperature creep failure of silver-aided diffusion bonds between steel, 15:32558 (R;US)
CW ultraviolet and visible laser action from ionized silver in an electron beam generated plasma, 15:33790 (J;US)
Comment on "Observation and structural determination of $\sqrt{3}\times\sqrt{3}$ $R30°$ reconstruction of the Si(111) surface", 15:32747 (J;US)
Determination of the bulk band structure of Ag in Ag/Cu(111) quantum-well systems, 15:32599 (J;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 5. Primary precious metals and mercury, secondary precious metals, secondary silver, secondary mercury. Final report, 15:33158 (R;US)
Encoding of the Burgess metal electrical resistivity model into SESAME format and its adaptation to the metal nickel, 15:32548 (R;US)
Intermediate mass fragment emission in the 161-MeV p+Ag reaction, 15:33542 (J;US)
Light scattering by surface acoustic waves on corrugated metal surfaces, 15:32598 (J;US)
Probability of ternary fission of ^{93}Nb and^{nat} Ag nuclei induced by 0.8-1.8 GeV photons, 15:33539 (R;BR)
The energetics associated with the formation of interfaces, multilayers and adlayers, 15:32812 (BA;US)

SILVER ALLOYS
Neutron scattering experiments on $YbXCu_4$ and $ErXCu_4$ (X=Au, Pd, and Ag), 15:32591 (J;US)

SIMS
See MASS SPECTROSCOPY

SINTERING
Utilization of waste heat in sintering process, 15:32500 (R;GB)

SIZEWELL NUCLEAR POWER STATION B
See SIZEWELL-B REACTOR
SIZEWELL-B REACTOR
Containment integrity beyond the design basis: A UK regulatory view, 15:32378 (RA;US)
Proposals for a one tenth scale model test of the Sizewell B containment, 15:32391 (RA;US)
The design of a 1/10th scale model of the Sizewell B Primary Containment, 15:32392 (RA;US)
SKYRME POTENTIAL
The stability of the classical Skyrme model SU(2) hedgehog soliton, 15:33475 (R;BR)
SKYRMIONS
See SKYRME POTENTIAL
SOLITONS
SLAGS
Immobilization of technetium in blast furnace slag grouts, 15:32245 (BA;US)
SLC
See STANFORD LINEAR COLLIDER
SLC DETECTORS
Electrostatic design of the barrel CRID [Cherenkov Ring Imaging Detector] and associated measurements, 15:32978 (R;US)
SLUDGES
See also SEWAGE SLUDGE
The removal and control of trace elements in coal and coal wastes, 15:32093 (RA;US)
SLUGS (FUEL)
See FUEL RODS
SLURRIES (FUEL)
See FUEL SLURRIES
SMECTITE
Transmission electron microscopy study of illite/smectite mixed layers, 15:33129 (R;CH)
SMELTING
Fiscal year 1989 annual report for the Sensors Development Program: Inert Electrodes Program, 15:32511 (R;US)
SODIUM
Core-level photoemission from alkali metals on Ru(001), 15:32594 (J;US)
The ionization of thermal and hyperthermal beams of Na, K, and Cs on Si(111) surfaces, 15:33646 (J;US)
SODIUM CHLORIDES
Study of metal corrosion using ac impedance techniques in the STS launch environment, 15:32549 (RA;US)
SODIUM FLUORIDES
Bubble attachment time measurements for selected rare-earth phosphate minerals in oleate solutions, 15:32798 (BA;US)
SODIUM NITRATES
Electrolysis at an anthracene crystal/aqueous NO_3^- solution interface: The role of crystal defects, 15:32813 (J;US)
SODIUM SULFATES
Special Wasteform Lysimeter Program wasteform characteristics, 15:32214 (R;US)
SODIUM URANATES
Investigation on U - O - Na, Pu - O - Na and U,Pu - O - Na phase diagrams, 15:32603 (R;FR;In French)
SOILS
Chemical Analysis
Summary of the 1987 soil sampling effort at the Idaho National Engineering Laboratory Test Reactor Area Paint Shop Ditch, 15:33125 (R;US)
Contamination
Health-hazard evaluation report HETA 87-371-1989, technical assistance to the Jamaican Ministry of Health, Kingston, Jamaica, 15:33075 (R;US)
Polychlorinated biphenyls: Occurrence in sediments and soils. January 1977-March 1990 (A Bibliography from the Selected Water Resources Abstracts data base). Report for January 1977-March 1990, 15:33187 (R;US)
Radiological oversight and certification report for the Lansdowne property, 105-107 East Stratford Avenue, Lansdowne, Pennsylvania, August 1988–June 1989, 15:33114 (R;US)
Superfund Record of Decision (EPA Region 2): FAA (Federal Aviation Administration) Technical Center, Atlantic County, New Jersey (First remedial action), September 1989, 15:32156 (R;US)
Superfund Record of Decision (EPA Region 5): Ionia City Landfill, Ionia, Michigan (First remedial action, September 1989), 15:33147 (R;US)
Superfund Record of Decision (EPA Region 6): Motco Superfund Site, La Marque, Texas (second remedial action), September 1989. Final report, 15:33146 (R;US)
Superfund Record of Decision (EPA Region 6): Sheridan Disposal Services Site, Waller County, Texas (Second remedial action), September 1989. Final report, 15:33177 (R;US)
Superfund Record of Decision (EPA Region 7): Arkansas City Dump Site, Arkansas City, Kansas (Second remedial action), September 1989. Final report, 15:32155 (R;US)
Superfund Record of Decision (EPA Region 9): Purity Oil Sales, CA. (First remedial action), September 1989, 15:32158 (R;US)
Decontamination
Assessing UST corrective action technologies: Site assessment and selection of unsaturated zone treatment technologies. Report for October 1987-September 1989, 15:32159 (R;US)
Enhanced bioremediation utilizing hydrogen peroxide as a supplemental source of oxygen: A laboratory and field study. Final report, August 1987-November 1989, 15:32157 (R;US)
Volume estimate of radium-contaminated soil in a section of Barrows Field Park, Glen Ridge, New Jersey, November–December 1989, 15:33115 (R;US)
Erosion
The effects of rainfall energy on soil erosion in Southern Nigeria, 15:33128 (R;XA)
Moisture
Field Lysimeter Test Facility: Second year (FY 1989) test results, 15:32228 (R;US)
Radiation Monitoring
Radiological effluents released from announced US continental tests, 1961 through 1988, 15:33035 (R;US)
Rapid determination of plutonium content on filters and smears using Alpha Liquid Scintillation, 15:32974 (R;US)
Radioassay
An aerial radiological survey of the Evans Area, US Army Communications-Electronics Command, Fort Monmouth, New Jersey: Date of survey, November 1988, 15:33055 (R;US)
Radionuclide Migration
A unified theory of radon transport in porous media: Model benchmark and soil parameter evaluations: Project annual report, 15:33140 (R;US)
Radionuclide uptake by pinetrees growing on lysimeters, 15:33123 (R;US)
Ressac program plants analytical experiments study of a code modelling the soil to plant transfer factor of cesium, 15:33117 (R;FR;In French)
Subsurface Science Program: Program overview and research abstracts, FY 1989–FY 1990, 15:33122 (R;US)
Resource Management
Soil survey versus crop production as a measure of soil productivity: Soil characteristics as predictors of corn and soybean yields, NCSS (National Cooperative Soil Survey) data base. Final report, 15:32102 (R;US)
Soil survey versus crop production as a measure of soil productivity: Soil-strength effects on row-crop yields. Final report, 15:32103 (R;US)
Sampling
An aerial radiological survey of the United States Department of Energy's Rocky Flats Plant, Golden, Colorado: Date of survey, July 1989, 15:33057 (R;US)
Multilaboratory validation study of PCBs in soils using Soxtec® extraction technique (Method 3541), 15:33119 (R;US)
Soil gas surveying at low-level radioactive waste sites, 15:32215 (R;US)
Summary of the 1987 soil sampling effort at the Idaho National Engineering Laboratory Test Reactor Area Paint Shop Ditch, 15:33125 (R;US)

Vitrification
Feasibility testing of in situ vitrification of uranium-contaminated soils, 15:32244 (BA;US)

SOLAR ACTIVITY
See also SOLAR FLARES
SOLAR PROMINENCES
SOLAR RADIO BURSTS
SOLAR WIND
Solar-Geophysical Data Number 544, December 1989. Part 1 (prompt reports). Data for November, October 1989, and late data, 15:33312 (R;US)
Solar-Geophysical Data Number 545, January 1990. Part 1 (prompt reports). Data for December, November 1989, and late data, 15:33313 (R;US)
Solar-Geophysical Data Number 545, January 1990. Part 2 (comprehensive reports). Data for July 1989 and miscellaneous, 15:33314 (R;US)

SOLAR ARCHITECTURE
Architectural and technical concerns pertaining to the design and operation of solar heating installations, 15:32289 (R;CA)
Daylighting as a passive solar energy option: an assessment of its potential in non-domestic buildings, 15:32478 (R;GB)

SOLAR COLLECTORS
Direct-contact heat transfer processes, 15:32292 (BA;US)
Solar swimming pool: Final project summary, 15:32489 (R;CA)

SOLAR ENERGY
Solar resources, 15:32278 (B;US)

SOLAR ENERGY CONVERSION
Solar resources, 15:32278 (B;US)

SOLAR EQUIPMENT
See also PHOTOELECTROCHEMICAL CELLS
PHOTOVOLTAIC POWER SUPPLIES
SOLAR COLLECTORS
SOLAR HEATING SYSTEMS
SOLAR WATER HEATERS
SOLAR WATER PUMPS
Architectural and technical concerns pertaining to the design and operation of solar heating installations, 15:32289 (R;CA)

SOLAR FLARES
Solar-Geophysical Data Number 543, November 1989. Part 2 (comprehensive reports). Data for May 1989 and miscellaneous, 15:33311 (R;US)

SOLAR HEATING SYSTEMS
See also PASSIVE SOLAR HEATING SYSTEMS
Architectural and technical concerns pertaining to the design and operation of solar heating installations, 15:32289 (R;CA)
Simulation of thermal conditions in a solar heating system with seasonal storage, 15:32293 (R;DK;In Danish)

SOLAR MODELS
See STAR MODELS

SOLAR PROMINENCES
Solar-Geophysical Data Number 543, November 1989. Part 2 (comprehensive reports). Data for May 1989 and miscellaneous, 15:33311 (R;US)

SOLAR RADIATION
Solar-Geophysical Data Number 543, November 1989. Part 2 (comprehensive reports). Data for May 1989 and miscellaneous, 15:33311 (R;US)

SOLAR RADIO BURSTS
Solar-Geophysical Data Number 543, November 1989. Part 2 (comprehensive reports). Data for May 1989 and miscellaneous, 15:33311 (R;US)

SOLAR WATER HEATERS
Solar swimming pool: Final project summary, 15:32489 (R;CA)

SOLAR WATER PUMPS
Solar powered pumping systems. Existing material, cost of a cubic meter, comparison with other pumping systems, maintenance, appendix, 15:32288 (R;FR;In French)

SOLAR WIND
Solar-Geophysical Data Number 545, January 1990. Part 1 (prompt reports). Data for December, November 1989, and late data, 15:33313 (R;US)

SOLDER FLUXES
See METALLURGICAL FLUX

SOLDERING FLUXES
See METALLURGICAL FLUX

SOLID STATE PHYSICS
Francis Bitter National Magnet Laboratory annual report, July 1988 through June 1989, 15:33630 (R;US)

SOLID WASTES
See also TAILINGS
Market review of demand for industrial waste combustors for on-site use, 15:32269 (R;GB)

SOLIDS
A constitutive model for the dynamic response of brittle materials, 15:33644 (J;US)
Atomic-scale modeling of low-energy ion-solid processes, 15:33342 (BA;US)
Circumfluous motion of a conductive liquid around solid objects in a magnetic field, 15:33607 (R;US)
Convoy electrons, 15:33616 (R;US)
Selection rules in resonance electron scattering from adsorbed molecules, 15:33649 (J;US)
Theoretical considerations on the hot-wire method applied to solids under pressure, 15:32990 (J;US)

SOLITONS
Comments on "Neutron-proton mass difference in the chiral solitonic bag model", 15:33584 (J;US)
Soliton-collision interferometer for the quantum nondemolition measurement of photon number: numerical results, 15:32996 (J;US)
The stability of the classical Skyrme model SU(2) hedgehog soliton, 15:33475 (R;BR)

SOLVENT EXTRACTION
Drop oscillations in liquid-liquid systems, 15:32872 (J;US)

SOLVENTS
See also ORGANIC SOLVENTS
Alternative solvents/technologies for paint stripping: Phase 1, 15:32505 (R;US)
Modeling organic-contaminant sorption impacts on aquifer restoration, 15:33169 (R;US)

SONDES
See PROBES

SOOT
The roles of PAH [polycyclic aromatic hydrocarbons] and acetylene in soot nucleation and growth, 15:32835 (R;US)

SORBENT INJECTION PROCESSES
Simultaneous SO_x/NO_x control: Technical report, April 1, 1987–March 31, 1988 including Quarterly technical progress report, January–March 1988, 15:32310 (R;US)

SOUND
See SOUND WAVES

SOUND WAVES
See also ULTRASONIC WAVES
Acoustic agglomeration of power plant fly ash for environmental and hot gas cleanup: Final report: Revised Version, 15:32311 (R;US)
Listening to turbulence: An example of scientific audiolization, 15:33388 (R;US)

SOURCE TERMS
PARTITION: A program for defining the source term/consequence analysis interface in the NUREG–1150 probabilistic risk assessments: User's guide, 15:32417 (R;US)

SOUTH AFRICA
Council for Nuclear Safety annual report 1988/89, 15:32256 (R;ZA;In English, Afrikaans)

SPACE GROUPS
Criticality of the three-state chiral clock model: a renormalisation group study, 15:33609 (R;BR)

SPACE HVAC SYSTEMS
Practical ice thermal storage applications, 15:32490 (B;US)

SPACE LATTICES
See CRYSTAL LATTICES

SPACE POWER REACTORS
Review of overall safety manual for space nuclear systems: An evaluation of a nuclear safety analysis methodology for plutonium-fueled space nuclear systems, 15:32357 (R;US)

SPACE VEHICLES
A hierarchical approach to large space structure control, 15:32497 (R;US)
Assembly of radioisotope power systems at Westinghouse Hanford Company, 15:32262 (R;US)
SEU characterization and design dependence of the SA3300 microprocessor, 15:33853 (R;US)
SPACE-TIME
On the minimum uncertainty of space-time geodesics, 15:33706 (R;HU)
Some notes on stationary vacuum space-times with shearing nongeodesic eigenrays, 15:33708 (R;HU)
Ten-dimensional Lovelock-type space-times, 15:33521 (J;US)
SPACECRAFT POWER SUPPLIES
Assembly of radioisotope power systems at Westinghouse Hanford Company, 15:32262 (R;US)
Radiation hardening of a high voltage IC technology (BCD-MOS), 15:32988 (R;US)
SPARK CHAMBERS
Simulation of the build-up phase of a high voltage low pressure gas discharge using Monte-Carlo-methods, 15:32975 (R;DE;In German)
SPARKS (ELECTRIC)
See ELECTRIC SPARKS
SPECIAL RELATIVITY THEORY
See RELATIVITY THEORY
SPECIMEN HOLDERS
See SAMPLE HOLDERS
SPECTRA (ABSORPTION)
See ABSORPTION SPECTRA
SPECTROMETERS
See also ELECTRON SPECTROMETERS
FOURIER TRANSFORM SPECTROMETERS
MASS SPECTROMETERS
OPTICAL SPECTROMETERS
Group fellowship training in nuclear spectroscopy instrumentation maintenance at the Seibersdorf Laboratories, 15:32983 (J;XA)
Spatial distribution of atomic and molecular species in inductively coupled plasmas (ICP): By monochromatic imaging and image analysis, 15:32792 (BA;US)
SPEED INDICATORS
See VELOCIMETERS
SPENT FUEL CASKS
Executive summary: Reactor critical benchmark calculations for burnup credit applications, 15:32333 (R;US)
SPENT FUEL ELEMENTS
A high-sensitivity, position-sensitive fission chamber for subcriticality measurement of spent fuel, 15:32197 (R;US)
Mass spectrometric measuring of nuclear fuel burnup, 15:32779 (R;CN;In Chinese)
SPENT FUEL STORAGE
Modeling of Zircaloy cladding degradation under repository conditions, 15:32239 (R;US)
SPENT FUELS
Monitored Retrievable Storage facility site screening and evaluation report: Volume 3, 15:32208 (R;US)
Monitored retrievable storage facility site screening and evaluation report: Volume 2, 15:32207 (R;US)
Monitored retrievable storage facility site screening and evaluation report: Volume 1, 15:32206 (R;US)
SPENT SHALES
Behavior of phenol and aniline on selected sorbents and energy-related solid wastes, 15:32081 (J;NL)
SPERM
See SPERMATOZOA
SPERMATIDS
See SPERMATOZOA
SPERMATOZOA
Single-sperm typing: Determination of genetic distance between the $^{G}\gamma$-globulin and parathyroid hormone loci by using the polymerase chain reaction and allele-specific oligomers, 15:33208 (J;US)
SPICULES
See SOLAR PROMINENCES
SPINORS
Beyond spinors, 15:33666 (R;FR)
SPRAY PONDS
See SPRAYS
SPRAYS
Parametric study of electrostatically charged sprays, 15:32862 (R;US)
SPRUCES
Progeny test of Norway Spruce stands in the Black Forest (areas of origin 840 08 and 840 09) aiming at: 1. Improvement of immission tolerance. 2. Conservation of genetic resources of damaged stands in high altitudes ('Gene Bank'), 15:33233 (R;DE;In German)
SRM
See CALIBRATION STANDARDS
STAINLESS STEEL-18-4-1
See STAINLESS STEELS
STAINLESS STEEL-19-9DL
See STAINLESS STEELS
STAINLESS STEEL-304
Ambient-temperature creep failure of silver-aided diffusion bonds between steel, 15:32558 (R;US)
STAINLESS STEEL-316
Environmentally assisted cracking in light water reactors, 15:32552 (RA;US)
HAZ liquation cracking behavior in newly developed lean 316 stainless steels, 15:32045 (R;US)
STAINLESS STEELS
Decontamination impacts on solidification and waste disposal, 15:32200 (R;US)
Encoding of the Burgess metal electrical resistivity model into SESAME format and its adaptation to the metal nickel, 15:32548 (R;US)
Environmentally assisted cracking in light water reactors, 15:32552 (RA;US)
Quantitative theory of sensitization, 15:32811 (BA;US)
Study of metal corrosion using ac impedance techniques in the STS launch environment, 15:32549 (RA;US)
STANDARD ELECTROWEAK MODEL
See WEINBERG-SALAM GAUGE MODEL
STANDARD MODEL
Comment on anomaly cancellation in the standard model, 15:33519 (J;US)
Comment on phenomenology of the almost standard model, 15:33439 (R;XA)
Minimal dynamical symmetry breaking of the standard model, 15:33482 (J;US)
Standard-model predictions for *CP* violation in B^0-meson decay, 15:33481 (J;US)
STANDARD REFERENCE MATERIALS
See CALIBRATION STANDARDS
STANDARDS
See also CALIBRATION STANDARDS
Primary Standards Laboratory report: 2nd half 1989, 15:32965 (R;US)
STANDING CROP
See BIOMASS
STANFORD LINEAR ACCELERATOR CENTER
SLAC [Stanford Linear Accelerator Center] site geology, ground motion and some effects of the October 17, 1989 earthquake, 15:33277 (R;US)
STANFORD LINEAR COLLIDER
Datum definition problems in accelerator alignment, 15:32910 (R;US)
Interactive beam tuning simulator for the SLC Final Focus, 15:32927 (BA;US)
Long ion chamber systems for the SLC (Stanford linear collider), 15:32947 (BA;US)
STAR ACCRETION
Accretion shock geometries in the magnetic variables, 15:33309 (R;US)
STAR EVOLUTION
See also STAR ACCRETION
Computer simulation of dust grain evolution, 15:33307 (RA;US)

STAR MODELS
Accretion shock geometries in the magnetic variables, 15:33309 (R;US)
STARCH GUM
See DEXTRIN
STARK EFFECT
1/n-expansion and scaling for the Stark effect in Rydberg atoms, 15:33334 (R;XA)
Strong-field Stark effect: Perturbation theory and 1/n-expansion, 15:33333 (R;XA)
START-UP (REACTOR)
See REACTOR START-UP
STATISTICAL MECHANICS
Squeezed states representation; an λ-expansion of statistical mechanics, 15:33703 (R;BR)
STEADY-STATE CONDITIONS
Assessment of TRAC-PF1/MOD1 Version 14.3 using separate effects critical flow and blowdown experiments: Volume 2, Figures, 15:32424 (R;US)
STEAM
Crossover from singular critical to regular classical thermodynamic behavior of fluids, 15:33396 (J;US)
STEAM COOLANT
See STEAM
STEAM GENERATORS
Environmentally assisted cracking in light water reactors, 15:32552 (RA;US)
Life assessment procedures for major LWR components, 15:32407 (RA;US)
Proceedings: Primary water stress corrosion cracking: 1989 EPRI remedial measures workshop, 15:32336 (R;US)
STEAM REFORMER PROCESSES
Development of methanol reformer, 15:32264 (R;JP)
STEEL INDUSTRY
See METAL INDUSTRY
STEEL-000KH20N20
See NICKEL-CHROMIUM STEELS
STEEL-000KH25
See STAINLESS STEELS
STEEL-000KH28
See STAINLESS STEELS
STEEL-00KH20N32T
See STAINLESS STEELS
STEEL-03KH13AG13
See STAINLESS STEELS
STEEL-08G2SFB
See CARBON STEELS
STEEL-0KH18G8N2T
See STAINLESS STEELS
STEEL-1-KH18N20T3P
See NICKEL-CHROMIUM STEELS
STEEL-12KH2MV8FB
See STEELS
STEEL-12KH2V5FB
See STEELS
STEEL-15KHG2SFMR
See CHROMIUM-MOLYBDENUM STEELS
STEEL-18MNV6
See STEELS
STEEL-20KHMF
See CHROMIUM-MOLYBDENUM STEELS
STEEL-2KH8V8M2K8
See CHROMIUM-MOLYBDENUM STEELS
STEEL-37KHN3T
See NICKEL-CHROMIUM STEELS
STEEL-38KH5MSFA
See CHROMIUM-MOLYBDENUM STEELS
STEEL-40KH2N5SM
See NICKEL-CHROMIUM STEELS
STEEL-CR18NI10-L
Phase transition in a shock loaded 304 stainless steel, 15:32535 (R;FR;In French)
STEEL-KH12N20T3P
See NICKEL-CHROMIUM STEELS
STEEL-KH18N22V2T2
See NICKEL-CHROMIUM STEELS
STEEL-KHN35VT
See NICKEL-CHROMIUM STEELS
STEEL-N26KHT1
See NICKEL-CHROMIUM STEELS
STEEL-VZH102
See NICKEL-CHROMIUM STEELS
STEEL-Z10CDV7
See CHROMIUM-MOLYBDENUM STEELS
STEELS
See also CARBON STEELS
FERRITIC STEELS
Heavy-section steel technology program - Fracture issues, 15:32405 (RA;US)
Microstructural trapping effects on hydrogen induced cracking of a microalloyed steel, 15:32590 (J;US)
Neutron exposure parameters for the metallurgical test specimens in the sixth heavy-section steel irradiation series, 15:32338 (R;US)
Power reactor embrittlement data base, 15:32551 (RA;US)
Tribology of amorphous alloys formed with ion beams, 15:32573 (BA;US)
STES
See SEASONAL THERMAL ENERGY STORAGE
STOPPING
See ABSORPTION
STORAGE (SPENT FUEL)
See SPENT FUEL STORAGE
STORAGE BATTERIES (LEAD-ACID)
See LEAD-ACID BATTERIES
STORAGE FACILITIES
183-H solar evaporation basins closure/post-closure plan: Revision 2, 15:32209 (R;US)
Detecting leaks: Successful methods step-by-step. Final report, 15:32162 (R;US)
Monitored Retrievable Storage facility site screening and evaluation report: Volume 3, 15:32208 (R;US)
Monitored retrievable storage facility site screening and evaluation report: Volume 2, 15:32207 (R;US)
Monitored retrievable storage facility site screening and evaluation report: Volume 1, 15:32206 (R;US)
SPR conceptual design: Supplement to salt dome geology and cavern stability analysis, Bayou Choctaw, Louisiana: Department of Energy Strategic Petroleum Reserve Program, Bayou Choctaw, Louisiana, 15:32123 (R;US)
STORES
See COMMERCIAL BUILDINGS
STRATEGIC DEFENSE INITIATIVE
See BALLISTIC MISSILE DEFENSE
STRATEGIC PETROLEUM RESERVE
Annual technical report for the onshore environmental baseline characterization, 15:32161 (R;US)
STRAW
Poly aromatic hydrocarbons in flue gas from straw-fueled boilers: Pilot investigation, 15:32271 (R;DK;In Danish)
STREAK CAMERAS
Application of Fabry-Perot velocimeter to high-speed experiments, 15:32981 (BA;US)
STREETS
See ROADS
STREPTOCOCCUS
DpnA, a methylase for single-strand DNA in the Dpn II restriction system, and its biological function, 15:33203 (J;US)
STRESS (BIOLOGICAL)
See BIOLOGICAL STRESS
STRESS CORROSION
Proceedings: Primary water stress corrosion cracking: 1989 EPRI remedial measures workshop, 15:32336 (R;US)
STRING MODELS
Construction of mixed fermionic-bosonic string models in four dimensions, 15:33486 (R;XA)
Non-linear σ-models and string theories, 15:33511 (BA;US)
On the unitarity of string propagation on SU(1,1), 15:33493 (R;XA)

String theory of Calabi-Yau compactifications, 15:33508 (R;DK)
The Weil-Petersson Kaehler form on the super Teichmueller space, 15:33478 (R;JP)
The sewing technique for strings and conformal field theories, 15:33509 (R;DK)
Total cross section of highly excited strings, 15:33499 (R;XA)

STRONTIUM
Experimental equations of state for calcium, strontium, and barium metals to 20 kbar from 4 to 295 K, 15:32593 (J;US)

STRONTIUM 90
Multicomponent ion-exchange equilibria in chabazite zeolite, 15:32203 (R;US)
Radionuclide uptake by pinetrees growing on lysimeters, 15:33123 (R;US)
Surveillance of Site A and Plot M report for 1989, 15:33137 (R;US)

STRONTIUM 97
Coexistence features in the spherical-deformed $A \approx 100$ transition region: Picosecond lifetime measurements in ^{97}Sr, ^{97}Y, and ^{97}Zr, 15:33545 (J;US)

STRONTIUM CHLORIDES
Antiferromagnetism in $Sr_2CuO_2Cl_2$, 15:32676 (J;US)
Synthesis, structure, and properties of $Sr_2CuO_2Cl_2$, 15:32675 (J;US)

STRONTIUM FLUORIDES
Chemical bonding and lattice mismatch in semiconductor-insulator heteroepitaxy: SrFsub 2on Si(111), 15:32736 (BA;US)

STRONTIUM OXIDES
Antiferromagnetism in $Sr_2CuO_2Cl_2$, 15:32676 (J;US)
Chemistry and superconducting behavior of Sb-substituted Bi/Pb-based oxides, 15:32626 (BA;US)
In-situ growth of superconducting films of Bi-Sr-Ca-Cu-O using magnetron sputtering, 15:32604 (R;US)
Interlayer coupling in high temperature superconductors, 15:32647 (BA;US)
Magnetic and pairing correlations in a three band Hubbard model, 15:32646 (BA;US)
O 2*p* holes: Temperature effects and surface characteristics of cuprate superconductors, 15:32689 (J;US)
S-N-S behavior of grain boundaries in polycrystalline $La_{1.85}Sr_{0.15}CuO_{4-y}$, 15:32901 (BA;US)
Synthesis, structure, and properties of $Sr_2CuO_2Cl_2$, 15:32675 (J;US)

STRUCTURAL CHEMICAL ANALYSIS
Assessment of coal cleanability for various beneficiation processes by SEM-based automated image analysis, 15:32089 (J;NL)

STRUCTURAL MODELS
A hierarchical approach to large space structure control, 15:32497 (R;US)

STRUCTURE (MOLECULAR)
See MOLECULAR STRUCTURE

STRUCTURES (BUILDINGS)
See BUILDINGS

SUBBITUMINOUS COAL
Trend analysis of coal gasification product yields in an entrained flow reactor: Final report, 15:32047 (R;US)

SUBDUCTION ZONES
Subduction zone tectonic studies to develop concepts for the occurrence of sediment subduction (Phase 2): Volume 2: Final report, 15:32169 (R;US)
Subduction zone tectonic studies to develop concepts for the occurrence of sediment subduction (Phase 2): Volume 3: Final report, 15:32170 (R;US)
Subduction zone tectonic studies to develop concepts for the occurrence of sediment subduction (Phase 2): Volume 1: Final report, 15:32168 (R;US)

SUBSIDENCE (GROUND)
See GROUND SUBSIDENCE

SUBSTRATES
Comparison between $LaGaO_3$, $LaAlO_3$,$KTaO_3$ and $SrTiO_3$ substrates for the epitaxial growth of $YBa_2Cu_3O_{7-x}$ thin films by a BaF_2 process, 15:32653 (BA;US)

SUBSURFACE ENVIRONMENTS
Subsurface Science Program: Program overview and research abstracts, FY 1989–FY 1990, 15:33122 (R;US)

SUBURBS
See URBAN AREAS

SUDDEN IONOSPHERIC DISTURBANCE
Solar-Geophysical Data Number 544, December 1989. Part 1 (prompt reports). Data for November, October 1989, and late data, 15:33312 (R;US)
Solar-Geophysical Data Number 545, January 1990. Part 1 (prompt reports). Data for December, November 1989, and late data, 15:33313 (R;US)

SULFATES
See also SODIUM SULFATES
Evaluation of the role of ozone, acid deposition, and other airborne pollutants in the forests of eastern North America. Forest Service general technical report, 15:33085 (R;US)
Urban aerosol transformation and transport modeling. Report for October 1985-October 1988, 15:33091 (R;US)

SULFUR
Multiple sulfur sites in the Cu(100)$p(2\times2)$-S surface structure, 15:32601 (J;US)

SULFUR 32 REACTIONS
Changes in target fragmentation mechanisms with increasing projectile energy in intermediate energy nuclear collisions, 15:33555 (J;US)

SULFUR 35
Measurement of the deposition and fate of sulfur-dioxide-35 in a pine plantation, 15:33113 (J;US)

SULFUR DIOXIDE
Anthropogenic sulfur dioxide emission in Far East Asia, 15:32098 (R;JP;In Japanese)
Beneficiated fine-particle coal as a source of energy in small-scale applications, 15:32115 (RA;US)
Emissions involved in acidic deposition processes: Methodology and results, 15:33048 (R;US)
Estimated reductions in SO_2 emissions from the 100 largest electric utility power plant emitters through coal cleaning, 15:32313 (RA;US)
Measurement of the deposition and fate of sulfur-dioxide-35 in a pine plantation, 15:33113 (J;US)
Results of emissions and ash testing in full-scale co-combustion tests of binder-enhanced dRDF pellets and high-sulfur coal, 15:32513 (R;US)
Simultaneous NO_x/SO_2 removal with dry sorbent injection, 15:32314 (RA;US)
Surface acoustic wave (SAW) gas microsensor for SO_2. Final report, 15:33084 (R;US)

SULFUR FLUORIDES
Search for a multiproperty empirical intermolecular potential for $XeSF_6$, 15:32817 (J;US)

SULFUR IONS
Enhanced radiative Auger emission from lithiumlike $_{16}S^{13+}$, 15:33381 (J;US)

SULFUR OXIDES
See also SULFUR DIOXIDE
Simultaneous SO_x/NO_x control: Technical report, April 1, 1987–March 31, 1988 including Quarterly technical progress report, January–March 1988, 15:32310 (R;US)

SULFUR SULFIDES
See SULFUR

SULFURIC ACID
Review, discussion, and summary: Toxicology, 15:33248 (R;US)

SUPERCONDUCTING CABLES
Fabrication of Rutherford-type superconducting cables for construction of dipole magnets, 15:32897 (BA;US)

SUPERCONDUCTING CAVITY RESONATORS
Status of superconducting RF cavity development, 15:32951 (BA;US)

SUPERCONDUCTING COILS
Investigations on cooling by forced flow of helium II driven by fountain effect pumps, 15:32865 (R;DE;In German)

SUPERCONDUCTING COMPOSITES
Effects of shock-induced defects on flux pinning in $YBa_2Cu_3O_{7-\delta}$, 15:32899 (BA;US)
SUPERCONDUCTING FILMS
Microwave surface impedance of granular superconductors, 15:32664 (BA;US)
Practical superconductor development for electrical power applications: Annual report for FY 1989, 15:32878 (R;US)
SUPERCONDUCTING JUNCTIONS
S-N-S behavior of grain boundaries in polycrystalline $La_{1.85}Sr_{0.15}CuO_{4-y}$, 15:32901 (BA;US)
SUPERCONDUCTING MAGNETS
Summary of construction details and test performance of recent series of 1.8 meter SSC dipoles at BNL, 15:32930 (R;US)
The magnet components database system, 15:32931 (R;US)
SUPERCONDUCTING SUPER COLLIDER
Computing and data handling requirements for SSC [Superconducting Super Collider] and LHC [Large Hadron Collider] experiments, 15:32939 (R;US)
Fabrication of Rutherford-type superconducting cables for construction of dipole magnets, 15:32897 (BA;US)
Federal research: Final site selection process for DOE's super collider, 15:32960 (R;US)
Information dissemination: Cost of mailing environmental impact statement for super collider, 15:32959 (R;US)
Relational databases for SSC design and control, 15:32916 (BA;US)
SUPERCONDUCTING WIRES
Practical superconductor development for electrical power applications: Annual report for FY 1989, 15:32878 (R;US)
SUPERCONDUCTIVITY
Elastic constants of two $Y_1Ba_2Cu_3O_x$ superconductors: x = 6.70 and 6.92, 15:32892 (BA;US)
NIST (National Institute of Standards and Technology) research reports, January 1990. Special pub, 15:33631 (R;US)
Pairing with fractional angular and "spinor" gap, 15:33653 (R;XA)
Phenomenological theory of magnetic structure in the high-temperature superconductors, 15:32662 (BA;US)
Progress in facilitating access to science and technology, highlighting superconductivity, 15:33655 (R;US)
Superconductivity in mixed boson-fermion systems, 15:33652 (R;XA)
Surface resistance of $YBa_2Cu_3O_7$ films deposited on $LaGaO_3$ substrates, 15:32900 (BA;US)
The state of the industry, 15:33656 (J;US)
SUPERCONDUCTORS
Band Theory
One-dimensional narrow-band model for heavy fermions and resonating valence bonds, 15:33659 (J;US)
Critical Field
Upper critical field of a $Sm_{1.85}Ce_{0.15}CuO_{4-y}$ single crystal: Interaction between superconductivity and antiferromagnetic order in copper oxides, 15:32670 (J;US)
Crystal Structure
Preparation and characterization of single phase $Ba_{1-x}K_xBiO_3$, 15:32651 (BA;US)
Elasticity
Elastic constants of two $Y_1Ba_2Cu_3O_x$ superconductors: x = 6.70 and 6.92, 15:32892 (BA;US)
Electronic Structure
Hole excitation spectra in cuprate superconductors: A comparative study of single- and multiple-band strong-coupling theories, 15:32681 (J;US)
Epitaxy
Comparison between $LaGaO_3$, $LaAlO_3$,$KTaO_3$ and $SrTiO_3$ substrates for the epitaxial growth of $YBa_2Cu_3O_{7-x}$ thin films by a BaF_2 process, 15:32653 (BA;US)
Fabrication
Health and safety guide for inorganic compounds and metals used in the fabrication of superconductive alloys, 15:33234 (R;US)
Processing chemically prepared $YBa_2Cu_3O_7$ precursor powders, 15:32898 (BA;US)
The production of high performance $YBa_2Cu_3O_7$ using nitrogen dioxide, 15:32666 (J;US)
Functional Models
Phenomenological model of the copper oxide superconductors, 15:33658 (J;US)
Government Policies
The state of the industry, 15:33656 (J;US)
Holes
O 2*p* holes: Temperature effects and surface characteristics of cuprate superconductors, 15:32689 (J;US)
Impurities
Universal reduction of T_c in strong-coupling superconductors by a small concentration of magnetic impurities, 15:33660 (J;US)
Magnetic Susceptibility
Phenomenological theory of magnetic structure in the high-temperature superconductors, 15:32662 (BA;US)
Medium Temperature
Dynamical information for Fe doped $YBa_2Cu_3O_7$ superconducting oxides obtained from high temperature Moessbauer studies, 15:32602 (R;BR)
Moessbauer Effect
Dynamical information for Fe doped $YBa_2Cu_3O_7$ superconducting oxides obtained from high temperature Moessbauer studies, 15.32602 (R;BR)
Parametric Analysis
Major normal and superconducting parameters of high-T_c oxides, 15:32690 (J;US)
Physical Radiation Effects
Radiation effects in magnetic and superconducting materials, 15:32665 (J;US)
Radiation induced amorphization in $YBa_2Cu_3O_7$ and $GdBa_2Cu_3O_7$ superconductors, 15:32896 (BA;US)
Positrons
Positron-annihilation momentum density in superconductors, 15:33657 (J;US)
Superlattices
Structural and chemical imaging of superconductors and semiconductors by high-resolution STEM, 15:32719 (BA;US)
Temperature Dependence
Temperature dependence of the lower critical field of single crystal $YBa_2Cu_3O_{7-\delta d}$, 15:32655 (BA;US)
Young Modulus
Elastic constants of two $Y_1Ba_2Cu_3O_x$ superconductors: x = 6.70 and 6.92, 15:32892 (BA;US)
SUPERCRITICAL FLOW
See TURBULENT FLOW
SUPERFUND
Federal-facilities Hazardous-Waste Compliance Manual. Final report, 15:32447 (R;US)
Guidelines for effective management of the Contract Laboratory Program. Part 1. Contract award. Part 2. Contract administration, 15:32448 (R;US)
Technology evaluation report: SITE program. CF Systems organics extraction system, New Bedford, Massachusetts. Volume 2. Final report, 15:33179 (R;US)
Technology evaluation report: SITE program. CF Systems organics extraction system, New Bedford, Massachusetts. Volume 1. Final report, 15:33178 (R;US)
SUPERGRAVITY
Fermion loops in the effective potential of N = 1 supergravity, with application to no-scale models, 15:33506 (R;US)
Jordan algebras and flat potentials at one loop, 15:33667 (R;FR)
SUPERLATTICES
Applications of strained layer superlattices, 15:32715 (R;US)
SUPERNOVA REMNANTS
Optical detection of the remnant of SN 1980K in NGC 6946, 15:33319 (J;US)
SUPERNOVAE
Recent results of JANZOS, 15:33295 (RA;JP)
SUPERSYMMETRY
A higher-order analysis of the effects of breaking supersymmetry for non-linear σ-models, 15:33472 (R;BR)
Dynamically generated fermionic masses, 15:33479 (BA;US)
Observed supersymmetry in baryon and meson spectra with IBFM, the interacting boson fermion model, 15:33441 (R;BR)
Open superstrings in four dimensions, 15:33520 (J;US)

String theory of Calabi-Yau compactifications, 15:33508 (R;DK)
The sewing technique for strings and conformal field theories, 15:33509 (R;DK)
Torsion-induced gauge superfield mass generation for gauge-invariant non-linear σ-models, 15:33473 (R;BR)

SUPERVOLTAGE RADIOTHERAPY
See RADIOTHERAPY

SURFACE COATING
Optical coatings processed by CO2 laser sintering, 15:32532 (R;FR)

SURFACE MINING
Determination of drainage density for surface-mine reclamation in the western US. Final report, 15:32099 (R;US)
Surface mining: Information of legal fees under the surface mining act, 15:32109 (R;US)

SURFACE PROPERTIES
Glancing incidence neutron scattering, 15:33614 (R;FR)

SURFACE WATERS
See also COASTAL WATERS
PONDS
SEAS
SWIMMING POOLS
Superfund Record of Decision (EPA Region 4): Ciba-Geigy (McIntosh Plant), AL. (First remedial action), September 1989, 15:33176 (R;US)
Superfund Record of Decision (EPA Region 5): Ionia City Landfill, Ionia, Michigan (First remedial action, September 1989), 15:33147 (R;US)
Surface-water hydrology and sedimentology manual. Final report, 15:32101 (R;US)
Surveillance of Site A and Plot M report for 1989, 15:33137 (R;US)

SURFACES
Nanometer-scale pulsed laser modification of the basal plane of graphite observed with STM [scanning tunneling microscopy], 15:32716 (R;US)
On hydrogen chemisorption on metals: The electron correlation effects, 15:33625 (R;XA)
Quantum state resolved desorption of CO from solid surfaces: Progress report, June 15, 1989–June 14, 1990, 15:33617 (R;US)
Roughening phase transition in surface growth, 15:33638 (J;US)

SURPLUS NUCLEAR FACILITIES
Multimedia assessment of health risks for the Weldon Spring site remedial action project, 15:32202 (R;US)

SURRY POWER STATION UNIT-1
See SURRY-1 REACTOR

SURRY-1 REACTOR
Analysis of core damage frequency, Surry, Unit 1 internal events appendices: Volume 3, Revision 1, Part 2, 15:32415 (R;US)
Analysis of core damage frequency: Surry, Unit 1 internal events: Volume 3, Revision 1, Part 1, 15:32414 (R;US)

SUSPENSIONS
Sedimentation of particles through quiescent suspensions, 15:33632 (R;US)

SUSPENSIONS (FUEL)
See FUEL SLURRIES

SWEDEN
Nuclear power industry: - activity discharge, - occupational exposures. Fourth quarter of 1988, 15:33606 (R;SE;In Swedish)
Public perception and acceptance of the siting of nuclear waste facilities in seven countries, 15:32218 (R;US)

SWIMMING POOLS
Energy conservation through mechanical dehumidification Miramicki Valley High School pool, Newcastle, N.B.: Final report, 15:32515 (R;CA)
Solar swimming pool: Final project summary, 15:32489 (R;CA)

SWITZERLAND
Public perception and acceptance of the siting of nuclear waste facilities in seven countries, 15:32218 (R;US)

SYMMETRY BREAKING
A consistent analysis for the quark condensate $<\phi\ \phi>$ in QCD, 15:33432 (R;CN)
Dynamically generated fermionic masses, 15:33479 (BA;US)
Z(6) model: criticality and break-collapse method, 15:33611 (R;BR)

SYNCHROPHASOTRONS
See SYNCHROTRONS

SYNCHROTRONS
See also BROOKHAVEN AGS
FERMILAB TEVATRON
Beam diagnostic for COSY-Juelich, 15:32948 (BA;US)

SYNTHETIC FUELS
Development of synthetic gasoline-production process, 15:32272 (R;JP)

T

TAILINGS
See also MILL TAILINGS
The removal and control of trace elements in coal and coal wastes, 15:32093 (RA;US)

TALC
Industrial-hygiene walk-through report, Cyprus Industrial Minerals Company, Bay Street Mill, Los Angeles, California, 15:33240 (R;US)

TANK FARMS
See STORAGE FACILITIES

TANTALUM
Correlated positron-electron emission in heavy-ion collisions at the Coulomb barrier, 15:33330 (R;DE)
Process variables in the preparation of high purity rare earth metals, 15:32799 (BA;US)

TANTALUM 181 TARGET
Calculation of positron spectra from heavy-ion collisions and study of the line structure, 15:33329 (R;DE;In German)

TANTALUM OXIDES
Protons and lattice defects in perovskite-related oxides: Progress report, July 1, 1989–April 30, 1990, 15:32611 (R;US)

TAR SAND OIL
See BITUMENS

TARIFFS
Energy security: Analysis of studies on economic consequences of an oil import tariff, 15:32149 (R;US)

TATB
Development of a high-tensile-strain plastic-bonded TATB explosive, 15:33030 (R;US)

TAU LEPTONS
See TAU PARTICLES

TAU PARTICLES
Measurement of the branching ratio for the decay $\tau^- \rightarrow e^- \bar{\nu}_e \nu_\tau$, 15:33420 (J;US)
Radiative corrections and semileptonic B decays, 15:33471 (J;US)

TAUONS
See TAU PARTICLES

TCA TOKAMAK
Measurement of the ion temperature in the tokamak TCA by collective Thomson diffusion in the far infrared, 15:33784 (R;CH;In French)

TECHNETIUM
Immobilization of technetium in blast furnace slag grouts, 15:32245 (BA;US)

TECHNETIUM COMPOUNDS
Effect of transition-metal substitutions on competing electronic transitions in the heavy-electron compound URu_2Si_2, 15:32761 (J;US)

TECHNICAL INFORMATION CENTER
Development of an Integrated Record Input System (IRIS) for DOE's Technical Information Center, 15:33858 (R;US)

TEKTITES
Obsidian hydration dating: Field, laboratory, and modeling results, 15:33279 (BA;US)

TELEVISION CAMERAS
Distance and clearance perception using forward-looking, vehicular television systems, 15:32496 (R;US)

TEMPERATURE (AMBIENT)
See AMBIENT TEMPERATURE

TERBIUM 151
Single-particle states in ^{151}Tm and ^{151}Er: Systematics of neutron states in *N*=83 nuclei, 15:33551 (J;US)

TERRESTRIAL ECOSYSTEMS
Annual technical report for the onshore environmental baseline characterization, 15:32161 (R;US)

TERTIARY RECOVERY
See ENHANCED RECOVERY

TESTES
Comparison of age-related changes in in vivo and in vitro measures of testicular steroidogenesis after acute cadmium exposure in the sprague-dawley rat, 15:33249 (R;US)

TEVATRON
See FERMILAB TEVATRON

TEXAS
An evaluation of the known remaining oil resource in the State of Texas: Project on Advanced Oil Recovery and the States, 15:32147 (R;US)
Superfund Record of Decision (EPA Region 6): Motco Superfund Site, La Marque, Texas (second remedial action), September 1989. Final report, 15:33146 (R;US)
Superfund Record of Decision (EPA Region 6): Sheridan Disposal Services Site, Waller County, Texas (Second remedial action), September 1989. Final report, 15:33177 (R;US)

TEXAS EXPERIMENTAL TOKAMAK
See TEXT DEVICES

TEXT DEVICES
A portable and independent edge fluctuation diagnostic: Technical progress report, September 14, 1989–May 14, 1990, 15:33736 (R;US)
Texas Experimental Tokamak: Technical progress report, April 1989–April 1990, 15:33811 (R;US)

TEXTILES
A new tool for cellulose degradation studies, 15:32732 (BA;US)

THALLIUM OXIDES
Hall effect mesurements in thin films of $Tl_2Ba_2CaCu_2O_x$, 15:32661 (BA;US)
O 2*p* holes: Temperature effects and surface characteristics of cuprate superconductors, 15:32689 (J;US)
Ordering in $Tl_2CaBa_2Cu_2O_8$ and $Tl_2Ba_2CuO_6$ studied by pair distribution function and Rietveld analysis, 15:32630 (BA;US)

THERMAL BARRIERS
Dust and ventilation effects on radiant barriers: Cooling season energy measurements: Final report, 15:32484 (R;US)

THERMAL BATTERIES
Resistivity measurements of halide-salt/MgO separators for thermal cells, 15:32441 (R;US)
Self-discharge study of Li-alloy/FeS_2 thermal cells, 15:32440 (R;US)

THERMAL CONDUCTIVITY
Theoretical considerations on the hot-wire method applied to solids under pressure, 15:32990 (J;US)

THERMAL ENERGY STORAGE EQUIPMENT
Architectural and technical concerns pertaining to the design and operation of solar heating installations, 15:32289 (R;CA)

THERMAL POLLUTION (AIR)
See AIR POLLUTION

THERMAL POLLUTION (WATER)
See WATER POLLUTION

THERMAL TESTING
Theoretical considerations on the hot-wire method applied to solids under pressure, 15:32990 (J;US)

THERMOELECTRIC CELLS
See THERMOELECTRIC GENERATORS

THERMOELECTRIC CONVERTERS
See THERMOELECTRIC GENERATORS

THERMOELECTRIC GENERATORS
Assembly of radioisotope power systems at Westinghouse Hanford Company, 15:32262 (R;US)

THERMOLUMINESCENT DOSEMETERS
Calibration of Mg_2SiO_4(Tb) thermoluminescent dosimeters for use in determining diagnostic X-ray doses to Adult Health Study participants, 15:33604 (R;JP)

THERMONUCLEAR DEVICES
See also ICF DEVICES
Investigations on cooling by forced flow of helium II driven by fountain effect pumps, 15:32865 (R;DE;In German)

THERMONUCLEAR REACTIONS
See also MUON-CATALYZED FUSION
Burn condition for fusion plasmas, helium particle confinement and exhaust efficiency, 15:33779 (R;DE)
Initial calorimetry experiments in the Physics Division, ORNL [Oak Ridge National Laboratory], 15:33723 (R;US)

THERMONUCLEAR REACTOR MATERIALS
Desorption of H_2O and H_2 from steel and $LiAlO_2$ by temperature programmed desorption, 15:33805 (R;US)

THERMONUCLEAR REACTORS
Controlled thermonuclear fusion: research on magnetic fusion: Experimental hall and remotely operated manipulators. Concept of a reactor, and his environmental impact, 15:33821 (R;CH;In French)
Current US efforts in fusion failure experience data, 15:33813 (R;US)
Experimental simulation of a gaseous plasma collector, 15:33834 (J;US)
Proceedings of the 2nd Yayoi workshop on fusion reactor engineering, 15:33825 (R;JP;In Japanese)
The new phase for JET and its objective, 15:33765 (RA;GB)

THERMONUCLEAR WEAPONS
See NUCLEAR WEAPONS

THIN FILMS
A new method for analyzing data from continuous depth-sensing microindentation tests, 15:32743 (J;US)
Amorphous and metastable phase formation in systems with positive heats of mixing using high-rate sputter deposition, 15:32569 (BA;US)
Ceramic epitaxial films and multilayers prepared by MOCVD, 15:32606 (R;US)
Deposition of dielectric optical coatings: A microstructural study of the deposited layers and interfaces, 15:32726 (BA;US)
In situ HVEM study of ion irradiation-induced grain growth in Au thin films, 15:32725 (BA;US)
Laser studies of the SiH radical/surface interaction during deposition of a thin film, 15:32638 (BA;US)
Mechanical properties of nanometre volumes of material: Use of the elastic response of small area indentations, 15:32559 (BA;US)
Metal silicides formed by direct ion beam deposition, 15:32627 (BA;US)
Microanalytical and structural characterization of optical materials by electron microscopy and related spectroscopies, 15:32637 (BA;US)
Microstructural studies of IAD and PVD Cr coatings by cross section transmission electron microscopy, 15:32734 (BA;US)
Nitrogen doping of ZnO prepared by organometallic chemical vapor deposition, 15:32642 (BA;US)
On the structure of carbon films deposited on Si(111) by mass-selected low energy C^+ beams, 15:32718 (BA;US)
Properties of films prepared from low surface area/density alumina-silica, 15:32615 (R;US)
The influence of thickness and wavelength on the mechanical properties of a compositionally modulated ceramic thin film, 15:32628 (BA;US)
Tribology of amorphous alloys formed with ion beams, 15:32573 (BA;US)
Utilization of polymer viscoelastic properties in acoustic wave sensor applications, 15:33008 (R;US)

THIO COMPOUNDS
See ORGANIC SULFUR COMPOUNDS

THIOBACILLUS FERROXIDANS
Genetic manipolation of acidophilic bacteria, 15:32077 (BA;US)

THIOPHENE
Microbial removal of organic sulfur from coal (bacterial degradation of sulfur containing heterocyclic compounds), 15:32055 (RA;US)

THIOPHENES
See POLYCYCLIC SULFUR HETEROCYCLES

THORIUM
Correlated positron-electron emission in heavy-ion collisions at the Coulomb barrier, 15:33330 (R;DE)

THORIUM 230
Multimedia assessment of health risks for the Weldon Spring site remedial action project, 15:32202 (R;US)

THORIUM 232
An aerial radiological survey of the Evans Area, US Army Communications-Electronics Command, Fort Monmouth, New Jersey: Date of survey, November 1988, 15:33055 (R;US)
Multimedia assessment of health risks for the Weldon Spring site remedial action project, 15:32202 (R;US)

THORIUM 232 REACTIONS
Calculation of positron spectra from heavy-ion collisions and study of the line structure, 15:33329 (R;DE;In German)

THORIUM 232 TARGET
Transient times of fission in $^{40}Ar+^{232}Th$ peripheral collisions, 15:33559 (R;DE)

THORIUM ALLOYS
The low-temperature phase diagram of $U_{2-x}Th_xBe_{13}$, 15:32581 (BA;US)

THORIUM D
See LEAD 208

THORIUM OXIDES
Magnetism, specific heat, and pressure-dependent reistivity of the electron-doped compounds LnMCuO(Ln = Pr,Nd,Sm,Eu,Gd:M = Ce,Th), 15:32641 (BA;US)

THORON
See RADON 220

THREE MILE ISLAND-2 REACTOR
Sensitivity analyses on reflooding effect on the TMI-2 accident by the SCDAP code, 15:32369 (R;JP;In Japanese)

THREE-DIMENSIONAL CALCULATIONS
Three-dimensional permeability and fluid flow, 15:32131 (R;NO)

THRUSTERS
Comparative three-dimensional flow analysis of MHD generators and seawater thrusters, 15:32473 (R;US)

THYRATRONS
A model for the optically triggered pseudo-spark thyratron using local field and beam-bulk methods, 15:33826 (BA;US)
Pulse power considerations for the generation of 45 μs, 200 keV electron beams for CO_2 lasers, 15:33827 (BA;US)

THYRISTORS
A new technique for hardening optically-triggered thyristors, 15:33043 (R;US)

TIGHT SANDS
See PERMEABILITY
SANDSTONES

TIN
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 7. Primary beryllium, primary nickel and cobalt, secondary nickel, secondary tin. Final report, 15:33160 (R;US)

TIN 124 TARGET
Excitation-energy sharing in uranium induced dissipative collisions, 15:33540 (R;DE)

TIN COMPOUNDS
See also TIN OXIDES
Improving the performance of $InAs_{1-x}Sb_x$/InSb infrared detectors grown by metal organic chemical vapor deposition, 15:32711 (R;US)

TIN OXIDES
Photoluminescence spectroscopy of thin indium-tin-oxide contracts on mercuric iodide substrates, 15:32632 (BA;US)

TITANIUM
Abrupt interfaces with novel structural and electronic properties: Metal-cluster deposition and metal-semiconductor junctions, 15:32600 (J;US)
Au-Ge-Ni-Ti ohmic contacts on gallium arsenide, 15:32537 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 9. Primary and secondary titanium, primary zirconium and hafnium. Final report, 15:33161 (R;US)
Fracto-emission from deuterated titanium: Supporting evidence for a fracto-fusion mechanism, 15:33791 (J;US)
Ion implantation and ion beam analysis of lithium niobate, 15:32657 (BA;US)
Small angle neutron scattering from nanophase titanium as a function of oxidation, 15:32622 (BA;US)
The effect of charge mixture ratio and particle size on igniter plume heat transfer characteristics, 15:32871 (R;US)

TITANIUM ALLOYS
An analysis of the low temperature, low and high strain-rate deformation of Ti-6Al-4V, 15:32589 (J;US)
Fabrication of Rutherford-type superconducting cables for construction of dipole magnets, 15:32897 (BA;US)
Identification of cleavage planes in the Al_3Ti-base alloy by electron channeling in the SEM, 15:32577 (BA;US)
Ion-beam mixing in amorphous and crystalline Fe-Ti, 15:32568 (BA;US)
Phase and microstructure of Fe modified Al_3Ti, 15:32585 (BA;US)
Structural energy differences in Al_3Ti: The role of tetragonal distortion in APB and twin energies, 15:32564 (BA;US)
Structure maps and phase stability in $AlTi_3$ alloyed with rare-earth elements, 15:32562 (BA;US)
The effect of simultaneous electron and Kr^+ irradiation on amorphization of CuTi, 15:32575 (BA;US)

TITANIUM CARBIDES
Tribology of amorphous alloys formed with ion beams, 15:32573 (BA;US)
Unlubricated sliding properties of ion beam and excimer laser mixed Fe-Ti-C multilayered films, 15:32649 (BA;US)

TITANIUM IONS
Correlation enhancement of the electron-impact ionization cross section for excited-state Ne-like ions, 15:33370 (J;US)

TITANIUM OXIDES
Ceramic epitaxial films and multilayers prepared by MOCVD, 15:32606 (R;US)
In situ surface-enhanced Raman spectroscopy using new TiO2 based substrates, 15:32796 (BA;US)
Microstructure of nonocrystalline ceramics, 15:32624 (BA;US)
Phase control of nanophase materials formed from ultrafine Ti of Pd powders, 15:32623 (BA;US)
Sintering of nanophase TiO_2 at 550°C, 15:32621 (BA;US)

TITANIUM SILICIDES
Electrical and structural properties of $TiSi_2$ films, 15:32737 (BA;US)

TLD (DOSEMETERS)
See THERMOLUMINESCENT DOSEMETERS

TLD SYSTEMS
See THERMOLUMINESCENT DOSEMETERS

TOKAMAK CHAUFAGE ALFVEN
See TCA TOKAMAK

TOKAMAK DEVICES
See also ASDEX TOKAMAK
CASTOR TOKAMAK
COMPACT IGNITION TOKAMAK
DOUBLET-3 DEVICE
ITER TOKAMAK
JFT-2 TOKAMAK
JFT-2M TOKAMAK
MT-1 TOKAMAK
TCA TOKAMAK
TEXT DEVICES
TORE SUPRA TOKAMAK
Characterization of disruptions in the Microwave Tokamak Experiment, MTX, 15:33787 (R;US)

Electromagnetic computations for fusion devices, 15:33731 (R;US)
Influence of an energetic ion population on tokamak plasma stability, 15:33793 (J;US)
Measurement of the internal magnetic field structure of tokamak plasmas, 15:33778 (R;DE;In German)
Microwave Tokamak Experiment: Overview and status, 15:33824 (R;US)
Modelling the edge plasma dynamics in a tokamak using Grad's approximation, 15:33757 (RA;CS;In Russian)
Neoclassical quasilinear transport theory of fluctuations in toroidal plasmas: Further considerations, 15:33794 (J;US)
Plasma confinement theory and transport simulation: Technical progress report, November 1, 1989–October 31, 1990, 15:33735 (R;US)
Safety factor on the axis of a tokamak during Ohmically heated sawtoothing discharges from a localized measurement of circular polarization of the Li I 6708 A line, 15:33799 (J;US)
Temperature distribution of a tokamak with a constant heat conductivity, 15:33785 (R;US)
Tokamak radiation measurements by microchannel plate detector, 15:33755 (RA;CS)
Transport simulation of the effect of impurity radiation on the high beta, ohmic start-up of the HBT-EP tokamak, 15:33733 (R;US)

TOLUENE
Health-hazard evaluation report HETA 89-007-1983, St. Thomas More Hospital, Canyon City, Colorado, 15:33236 (R;US)
Modification of coal surfaces with methyl radicals, 15:32057 (RA;US)

TOLYL RADICALS
Gas-phase heats of formation of $C_7H_7^+$ isomers: M-tolyl, p-tolyl, and benzyl ions, 15:32822 (J;US)

TORE SUPRA
See TORE SUPRA TOKAMAK

TORE SUPRA TOKAMAK
Controlled thermonuclear reactions and Tora Supra program, 15:33814 (R;FR;In French)

TOTAL-ABSORPTION SPECTROMETERS
See SHOWER COUNTERS

TOWERS (EXTRACTION)
See EXTRACTION COLUMNS

TOXIC MATERIALS
Encapsulation of mixed radioactive and hazardous waste contaminated incinerator ash in modified sulfur cement, 15:32199 (R;US)
Evaluating direct toxicity and food-chain effects in aquatic systems using natural periphyton communities, 15:33139 (R;US)
Inhalation Toxicology Research Institute annual report, October 1, 1987–September 30, 1988, 15:33223 (R;US)
Strategies for assessing the cumulative effects of wetland alteration on water quality, 15:33172 (R;US)

TOXIC SUBSTANCES CONTROL ACT
Air toxics compliance issues and case histories from the Kentucky experience, 15:32450 (BA;US)

TRACE ELEMENTS
See ELEMENTS

TRAFFIC CONTROL
Traffic congestion: Federal efforts to improve mobility, 15:32493 (R;US)
Traffic congestion: Trends, measures, and effects, 15:32492 (R;US)

TRAINING-RESEARCH REACTOR KYOTO
See KUR REACTOR

TRANSFER (HEAT)
See HEAT TRANSFER

TRANSFER (IN ENVIRONMENT)
See RADIONUCLIDE MIGRATION

TRANSFORMERS
Cast coil transformer fire susceptibility and reliability study, 15:32880 (R;US)

TRANSISTORS
See also FIELD EFFECT TRANSISTORS
MOS TRANSISTORS
Bipolar transistor fabrication using gas immersion laser doping, 15:32895 (BA;US)
Evidence that similar point defects cause 1/f noise and radiation-induced-hole trapping in metal-oxide-semiconductor transistors, 15:32749 (J;US)
Measurements of 1/f noise in A-Si:H pin diodes and thin-film-transistors, 15:32977 (R;US)

TRANSITION ELEMENTS
See also CHROMIUM
COBALT
COPPER
GOLD
HAFNIUM
IRON
MANGANESE
MOLYBDENUM
NICKEL
NIOBIUM
RHENIUM
SILVER
TANTALUM
TECHNETIUM
TITANIUM
TUNGSTEN
VANADIUM
YTTRIUM
ZIRCONIUM
Low-temperature, sulfur-tolerant homogeneous catalysts for the water-gas shift reaction: Final report, 15:32050 (R;US)

TRANSITION METALS
See TRANSITION ELEMENTS

TRANSLATORS
POSC: A Partitioning and Optimizing SISAL Compiler: Revision 1, 15:33854 (R;US)

TRANSMISSION (HEAT)
See HEAT TRANSFER

TRANSMISSION LINES
See POWER TRANSMISSION LINES

TRANSPORT (CHARGED-PARTICLE)
See CHARGED-PARTICLE TRANSPORT

TRANSPORTATION SYSTEMS
See also BUSES
MASS TRANSIT SYSTEMS
Co-processing and tar-sands resid: A new approach to alternative transportation fuels, 15:32078 (BA;US)
Criticality experiments with neutron flux traps containing voids, 15:32198 (R;US)
National urban-mass-transportation statistics. 1988 Section 15. Annual report. Report for 1 January-31 December 1988, 15:32495 (R;US)

TRANSURANIUM ELEMENTS
See also PLUTONIUM
Revised Eh-pH diagrams (25 C, one bar) for uranium and transuranic elements: Application to radioactive waste studies, 15:32809 (BA;US)

TRANSURANIUM WASTES
See ALPHA-BEARING WASTES

TRAPPING
Field dependence of interface trap buildup in Si-gate MOS devices, 15:32882 (R;US)

TREATIES
A decision-analysis process to support verification technology research and development, 15:32528 (R;US)

TRICHLOROMETHANE
See CHLOROFORM

TRIGA-1-ARIZONA REACTOR
Safety Evaluation Report related to the renewal of the operating license for the TRIGA training and research reactor at the University of Arizona (Docket No. 50-113), 15:32376 (R;US)

TRIGGER CIRCUITS
A new technique for hardening optically-triggered thyristors, 15:33043 (R;US)

TRIPLET PARTICLES
See QUARKS

TRISTAN PROJECT
See TRISTAN STORAGE RINGS
TRISTAN STORAGE RINGS
Upgrading of TRISTAN by superconducting RF system, 15:32964 (BA;US)
TRITIUM
Accelerator production of tritium (APT), 15:33812 (R;US)
Experiments on tritium behavior in beryllium, (2): Tritium released by recoil and diffusion, 15:32547 (R;JP;In Japanese)
Integrodifferential equation approach. Pt. 2. Triton and α-particle wave functions. Graphical plots, 15:33563 (R;DE)
Pantex Plant site environmental report for calendar year 1988, 15:33062 (R;US)
Surveillance of Site A and Plot M report for 1989, 15:33137 (R;US)
Thermal conductivity of condensed D-T and T_2, 15:32674 (J;US)
Trapping of deuterium at damage in graphite, 15:32710 (R;US)
TRITIUM EXTRACTION PLANT
Nuclear materials: Information on DOE's replacement tritium facility, 15:32194 (R;US)
TRITON REACTIONS
Muon reactivation in muon-catalyzed *d-t* fusion from accurate *p*-He^+ stripping and excitation cross sections, 15:33368 (J;US)
TRU WASTES
See ALPHA-BEARING WASTES
TRX-1
See REVERSE-FIELD PINCH
TSCHEBYSCHEFF APPROXIMATION
See POLYNOMIALS
TUBES
Life assessment procedures for major LWR components, 15:32407 (RA;US)
TUBES (CONDUITS)
See PIPES
TUFF
Electric logging and electrical properties of rocks in Rainier Mesa area, Nevada Test Site, Nevada, 15:32717 (R;US)
TUMORS
See NEOPLASMS
TUNGSTEN
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 6. Primary tungsten, secondary tungsten and cobalt, primary molybdenum and rhenium, secondary molybdenum and vanadium. Final report, 15:33159 (R;US)
Encoding of the Burgess metal electrical resistivity model into SESAME format and its adaptation to the metal nickel, 15:32548 (R;US)
High resolution electron microscopy study of as-prepared and annealed tungsten-carbon multilayers, 15:32579 (BA;US)
Mechanical properties of nanometre volumes of material: Use of the elastic response of small area indentations, 15:32559 (BA;US)
Minerals yearbook, 1988. Tungsten, 15:32456 (R;US)
Process variables in the preparation of high purity rare earth metals, 15:32799 (BA;US)
TUNGSTEN 180
Quadrupole moments and band-mixing in tungsten nuclei, 15:33595 (J;US)
TUNGSTEN 182
Quadrupole moments and band-mixing in tungsten nuclei, 15:33595 (J;US)
TUNGSTEN 184
Quadrupole moments and band-mixing in tungsten nuclei, 15:33595 (J;US)
TUNGSTEN 186
Quadrupole moments and band-mixing in tungsten nuclei, 15:33595 (J;US)
TUNGSTEN ALLOYS
See also HAVAR
Amorphous and metastable phase formation in systems with positive heats of mixing using high-rate sputter deposition, 15:32569 (BA;US)
TUNING
An algorithm for using a slide-screw tuner as a computer-controlled impedance, 15:32883 (R;US)
TURBINE BLADES
Aerodynamic pressure measurements on a rotating wind turbine blade, 15:32306 (R;US)
TURBULENT FLOW
Demonstration of the feasibility of laser induced fluorescence for arc jet flow diagnostics, 15:32866 (R;US)
Turbulence modeling in the SHALE code, 15:33386 (R;US)
3-DIMENSIONAL CALCULATIONS
See THREE-DIMENSIONAL CALCULATIONS

U

UCLLL
See LAWRENCE LIVERMORE LABORATORY
UJM
See JET MODEL
UJV
Main tasks of the Nuclear Research Institute in the period till the year 2000: Preliminary version, 15:33835 (R;CS;In Czech)
ULTRASONIC WAVES
Acoustical and dynamic mechanical characterization of fiber-matrix interface bonds in ceramic composites, 15:32066 (R;US)
ULTRASONICS
See ULTRASONIC WAVES
UNCORRELATED-JET MODEL
See JET MODEL
UNDERGROUND DISPOSAL
Sediment study - intermediate report 1988: disposal options for long lived radioactive waste in Swiss sedimentary formations: Executive summary, 15:32223 (R;CH)
UNDERGROUND MINING
Node-based network analysis and its application to mine ventilation, 15:32876 (BA;US)
Three-dimensional computer modeling of particulate flow around dust monitors, 15:32877 (BA;US)
UNDULATORS
See WIGGLER MAGNETS
UNIPOLAR TRANSISTORS
See FIELD EFFECT TRANSISTORS
UNITED KINGDOM
Containment integrity beyond the design basis: A UK regulatory view, 15:32378 (RA;US)
Public perception and acceptance of the siting of nuclear waste facilities in seven countries, 15:32218 (R;US)
UNIVERSE
Proceedings of workshop on dark matter and the structure of the universe, 15:33315 (R;JP)
UNSOLICITED PROPOSALS
See PROPOSALS
URANIUM
Feasibility testing of in situ vitrification of uranium-contaminated soils, 15:32244 (BA;US)
NIOSH (National Institute for Occupational Safety and Health) Testimony on the safety of nuclear facility workers by P. J. Bierbaum on April 22, 1985, 15:32255 (R;US)
Revised Eh-pH diagrams (25 C, one bar) for uranium and transuranic elements: Application to radioactive waste studies, 15:32809 (BA;US)
Some factors affecting the accuracy of uranium content determined by DNC measurement, 15:32970 (R;CN;In Chinese)
URANIUM 234
Pantex Plant site environmental report for calendar year 1988, 15:33062 (R;US)
Surveillance of Site A and Plot M report for 1989, 15:33137 (R;US)
URANIUM 235
A new resonance region evaluation of neutron cross sections for ^{235}U, 15:33560 (J;US)
CCS-I: a code to analyze a dynamic behavior of uranium enrichment process in a centrifuge cascade: An application to the safeguards effectiveness assessment, 15:33847 (R;JP)

Surveillance of Site A and Plot M report for 1989, 15:33137 (R;US)
URANIUM 238
An aerial radiological survey of the Evans Area, US Army Communications-Electronics Command, Fort Monmouth, New Jersey: Date of survey, November 1988, 15:33055 (R;US)
Multimedia assessment of health risks for the Weldon Spring site remedial action project, 15:32202 (R;US)
Pantex Plant site environmental report for calendar year 1988, 15:33062 (R;US)
Surveillance of Site A and Plot M report for 1989, 15:33137 (R;US)
URANIUM 238 REACTIONS
Excitation-energy sharing in uranium induced dissipative collisions, 15:33540 (R;DE)
URANIUM 238 TARGET
Direct measurement of the branching ratio Γ_n/Γ_f of ^{238}U in inelastic alpha scattering in the giant resonance region, 15:33561 (J;US)
URANIUM ALLOYS
The low-temperature phase diagram of $U_{2-x}Th_xBe_{13}$, 15:32581 (BA;US)
URANIUM DEPOSITS
Genesis, alteration and recent waterbearing structures of the Krunkelbach (Menzenschwand, Southern Black Forest) uranium deposit, 15:32192 (R;CH;In German)
URANIUM DIOXIDE
Investigation on U - O - Na, Pu - O - Na and U,Pu - O - Na phase diagrams, 15:32603 (R;FR;In French)
Reduction of UO_{2+x} by atomic hydrogen, 15:32834 (J;US)
URANIUM II
See URANIUM 234
URANIUM IONS
Correlated positron-electron emission in heavy-ion collisions at the Coulomb barrier, 15:33330 (R;DE)
Improved many-body perturbation theory calculations of the n=2 states of lithiumlike uranium, 15:33374 (J;US)
URANIUM ORES
Long-term stability of solid standards for radiochemical analysis, 15:32785 (R;US)
URANIUM SILICIDES
Effect of transition-metal substitutions on competing electronic transitions in the heavy-electron compound URu_2Si_2, 15:32761 (J;US)
URBAN AREAS
National urban-mass-transportation statistics. 1988 Section 15. Annual report. Report for 1 January-31 December 1988, 15:32495 (R;US)
UREA
Microencapsulation of silicon nitride particles with yttria and yttria-alumina precursors, 15:32668 (J;US)
Simultaneous NO_x/SO_2 removal with dry sorbent injection, 15:32314 (RA;US)
UREA-FORMALDEHYDE FOAMS
Unusual formaldehyde-induced hypersensitivity in two schoolgirls, 15:33257 (R;US)
URINALYSIS
See URINE
URINE
Rapid determination of nicotine in urine by direct thermal desorption ion trap mass spectrometry, 15:32782 (R;US)
US DOD
Defense Energy Information System (DEIS). Directive, 15:33861 (R;US)
Military Liaison Committee to the Department of Energy. Directive, 15:33018 (R;US)
Strategic Defense Initiative Organization. Directive, 15:32527 (R;US)
US DOE
See also BNL
HANFORD RESERVATION
IDAHO NATIONAL ENGINEERING LABORATORY
KANSAS CITY PLANT
LAWRENCE LIVERMORE LABORATORY
NEVADA TEST SITE
ORGDP
ORNL
PINELLAS PLANT
ROCKY FLATS PLANT
SANDIA LABORATORIES
SAVANNAH RIVER PLANT
STANFORD LINEAR ACCELERATOR CENTER
TECHNICAL INFORMATION CENTER
WIPP
Y-12 PLANT
Development of an Integrated Record Input System (IRIS) for DOE's Technical Information Center, 15:33858 (R;US)
Energy management: DOE has not shown systems contracting to be in government's best interest, 15:32464 (R;US)
Guide for technical analysis of budget proposals for financial assistance, 15:33837 (R;US)
Guide for technical analysis of cost proposals for acquisition contracts, 15:33836 (R;US)
Primary Standards Laboratory report: 2nd half 1989, 15:32965 (R;US)
Sandia National Laboratories data engineering for DOE production agencies, 15:33863 (R;US)
Technology '89: R and D Laboratory technology transfer program: Accomplishments in technology transfer from DOE [Department of Energy] and it laboratories, 15:32463 (R;US)
The technology transfer process: Background for the US national energy strategy, 15:32467 (R;US)
US NRC
Indexes to Nuclear Regulatory Commission issuances, July–December 1989: Volume 30, Index 2, 15:32328 (R;US)
US ORGANIZATIONS
See also NASA
US DOD
US DOE
US NRC
Defense Nuclear Agency (DNA). Directive, 15:33015 (R;US)
USTAV JADERNYCH VYZKUMU
See UJV
UTERINE CERVIX CARCINOMA
See CARCINOMAS

V

VA CHARACTERISTIC
See ELECTRIC CONDUCTIVITY
VALENCE ELECTRONS
See ELECTRONS
VALVES
Ceramic valve development for heavy-duty low heat rejection diesel engines, 15:32521 (J;US)
Plug valve, 15:32859 (P;US)
Preliminary observations of upcoming Phase II gate valve flow interruption tests, 15:32408 (RA;US)
Value-impact analysis of regulatory options for resolution of Generic Issue C-8: MSIV [Main Steam Isolation Valve] leakage and LCS [Leakage Control System] failure, 15:32419 (R;US)
VANADIUM
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 6. Primary tungsten, secondary tungsten and cobalt, primary molybdenum and rhenium, secondary molybdenum and vanadium. Final report, 15:33159 (R;US)
Minerals yearbook, 1988. Vanadium, 15:32459 (R;US)
VANADIUM ALLOYS
An analysis of the low temperature, low and high strain-rate deformation of Ti-6Al-4V, 15:32589 (J;US)
[Neutron scattering studies of spatial correlations in Fe-V and Fe-Cr alloys]: Foreign trip report, September 30, 1989–April 23, 1990, 15:32554 (R;US)
VANADIUM OXIDES
Ceramic epitaxial films and multilayers prepared by MOCVD, 15:32606 (R;US)
Unifying trends found for the V_NO_{2N-1} series by the application of hydrostatic pressure, 15:32695 (J;US)

VAPORS
Soil gas surveying at low-level radioactive waste sites, 15:32215 (R;US)
VECTOR FIELDS
Superconformal algebra and central extension of meromorphic vector fields with multipoles on super-Riemann sphere, 15:33490 (R;XA)
VEGETATION
See PLANTS
VEHICLES
See also BUSES
ELECTRIC-POWERED VEHICLES
SPACE VEHICLES
Distance and clearance perception using forward-looking, vehicular television systems, 15:32496 (R;US)
Insulating coatings (excluding electrical insulation). January 1980-November 1989 (A Bibliography from World Surface Coatings Abstracts). Report for January 1980-November 1989, 15:32487 (R;US)
VELOCIMETERS
Application of Fabry-Perot velocimeter to high-speed experiments, 15:32981 (BA;US)
VENEZUELA
A sulfur isotope data analysis of crude oils from the Bolivar coastal fields (BCF), Venezuela, 15:32164 (BA;US)
VERIFICATION
A decision-analysis process to support verification technology research and development, 15:32528 (R;US)
VESSELS
See CONTAINERS
VESSELS (CHEMICAL REACTIONS)
See CHEMICAL REACTORS
VESSELS (PRESSURE)
See PRESSURE VESSELS
VESSELS (REACTOR)
See REACTOR VESSELS
VINYL CHLORIDE
Vinyl chloride and polyvinyl chloride: Toxicology. April 1978-November 1989 (A Bibliography from the Life Sciences Collection data base). Report for April 1978-November 1989, 15:33251 (R;US)
VISCOSITY
Utilization of polymer viscoelastic properties in acoustic wave sensor applications, 15:33008 (R;US)
VITAMIN C
See ASCORBIC ACID
VITRIFICATION
Control loop and unit operational realtime modeling on a Distributed Control System, 15:32242 (R;US)
VOIDS
Criticality experiments with neutron flux traps containing voids, 15:32198 (R;US)
VOLCANIC GASES
Volcanic eruptions: Atmospheric effects. May 1970-February 1990 (A Bibliography from the NTIS data base). Report for May 1970-February 1990, 15:33100 (R;US)
VOLT-AMPERE CHARACTERISTIC
See ELECTRIC CONDUCTIVITY
VORTICES (MAGNETIC)
See MAGNETIC FLUX

W

W MINUS BOSONS
Probing the $WW\gamma$ vertex at the Fermilab Tevatron Collider, 15:33422 (J;US)
Weak-boson production by charm quarks, 15:33421 (J;US)
W-boson-plus-two-jet production at the Fermilab Tevatron, 15:33453 (J;US)
W PLUS BOSONS
Probing the $WW\gamma$ vertex at the Fermilab Tevatron Collider, 15:33422 (J;US)
Weak-boson production by charm quarks, 15:33421 (J;US)
W-boson-plus-two-jet production at the Fermilab Tevatron, 15:33453 (J;US)
WACKERSDORF REPROCESSING PLANT
Report of an environmental radioactivity measurement campaign in the Schwandorf region, 1988, 15:33127 (R;DE;In German)
WAKEFIELD ACCELERATORS
Nonlinear effects in plasma wake field acceleration (PWFA), 15:33781 (RA;JP)
WALLS
Insulating coatings (excluding electrical insulation). January 1980-November 1989 (A Bibliography from World Surface Coatings Abstracts). Report for January 1980-November 1989, 15:32487 (R;US)
WARFARE
A user's guide to the SCABBARD scenario language: Edition 2, 15:33022 (R;US)
WASTE BURIAL
See UNDERGROUND DISPOSAL
WASTE CHEMICALS
See CHEMICAL WASTES
WASTE FORMS
Effect of environmental materials on R7T7 nuclear waste glass alteration. Clay effect, 15:32201 (R;FR;In French)
Encapsulation of mixed radioactive and hazardous waste contaminated incinerator ash in modified sulfur cement, 15:32199 (R;US)
Results of field testing of waste forms using lysimeters, 15:32217 (R;US)
WIPP/SRL [Waste Isolation Pilot Plant/Savannah River Laboratory] in-situ tests: Compositional correlations of MIIT [Materials Interface Interactions Test] waste glasses, 15:32213 (R;US)
WASTE ISOLATION PILOT PLANT
See WIPP
WASTE MANAGEMENT
See also RADIOACTIVE WASTE MANAGEMENT
WASTE PROCESSING
Waste minimization in historical perspective, 15:32512 (BA;US)
WASTE PROCESSING
See also RADIOACTIVE WASTE PROCESSING
Forum on innovative hazardous-waste-treatment technologies: Domestic and international. Held in Atlanta, Georgia on Hune 19-21, 1989. Technical papers, 15:33132 (R;US)
WASTE PROCESSING PLANTS
Description of Risk Reduction Engineering Laboratory: Test and evaluation facilities, 15:33163 (R;US)
WASTE SOLUTIONS
See LIQUID WASTES
WASTE TREATMENT
See WASTE PROCESSING
WASTE WATER
Air toxics compliance issues and case histories from the Kentucky experience, 15:32450 (BA;US)
Coupled biological downflow fluid bed reactor treatment of synfuels wastewater, 15:33189 (BA;US)
Radiological oversight and certification report for the Lansdowne property, 105-107 East Stratford Avenue, Lansdowne, Pennsylvania, August 1988–June 1989, 15:33114 (R;US)
WASTEFORMS
See WASTE FORMS
WATER
See also DRINKING WATER
FRESH WATER
GROUND WATER
SEAWATER
WASTE WATER
Hanford Environmental Dose Reconstruction Project: Monthly report, 15:33102 (R;US)
Radiological effluents released from announced US continental tests, 1961 through 1988, 15:33035 (R;US)
Rate constants for the reaction, $O + H_2O \rightarrow OH + OH$, over the temperature range, 1500–2400 K, by the flash photolysis-shock tube technique: A further consideration of the back reaction, 15:32781 (R;US)

The manganese site of the photosynthetic water-splitting enzyme, 15:32285 (J;US)
Water oxidation in photosystem II: From radical chemistry to multielectron chemistry, 15:32286 (J;US)

WATER COOLANT
See WATER

WATER COOLED REACTORS
See also ATR REACTOR
BWR TYPE REACTORS
PWR TYPE REACTORS
3-D FEM analysis of 1:6 scale reinforced concrete containment under static overpressurization and local analysis of liner plant tearing, 15:32401 (RA;US)
Analysis predictions vs. test results of the 1:6-scale reinforced concrete containment tested at Sandia National Laboratories, 15:32398 (RA;US)
Analytical correlation and post-test analysis of the Sandia 1:6 scale reinforced concrete containment test, 15:32399 (RA;US)
Beta-quenched Zircaloy-4: Effects of thermal aging and neutron irradiation, 15:32583 (BA;US)
Comparison between theoretical and experimental results of the 1/6 scale concrete model under internal pressure, 15:32397 (RA;US)
Containment loading by deliberate ignition of flammable gas mixtures, 15:32381 (RA;US)
Design considerations for severe accident containment performance, 15:32379 (RA;US)
Internal hydriding in irradiated defected Zircaloy fuel rods, 15:32572 (BA;US)
Life assessment procedures for major LWR components, 15:32407 (RA;US)
Melt propagation in dry core debris beds, 15:32426 (J;US)
NFAP calculation of pressure response of 1/6th scale model containment structure, 15:32394 (RA;US)
Post-test analysis of a piping penetration in a 1:6-scale model of a reinforced concrete containment building, 15:32400 (RA;US)
Progress in post-test analyses of a 1:6 scale lined and reinforced concrete containment model, 15:32393 (RA;US)
Some post-test analyses of the 1/6th Sandia containment, 15:32396 (RA;US)
Synopsis of the results of a test of a reinforced concrete containment, 15:32395 (RA;US)

WATER DISTRIBUTION
See WATER SUPPLY

WATER HEATING
Energy conservation through mechanical dehumidification Miramicki Valley High School pool, Newcastle, N.B.: Final report, 15:32515 (R;CA)

WATER MODERATOR
See WATER

WATER POLLUTION
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 7. Primary beryllium, primary nickel and cobalt, secondary nickel, secondary tin. Final report, 15:33160 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 5. Primary precious metals and mercury, secondary precious metals, secondary silver, secondary mercury. Final report, 15:33158 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 4. Primary zinc, primary lead, secondary lead, primary antimony. Final report, 15:33157 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 10. Primary and secondary germanium and gallium, primary rare earth metals, secondary indium. Index. Final report, 15:33162 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 9. Primary and secondary titanium, primary zirconium and hafnium. Final report, 15:33161 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 3. Primary copper smelting, primary electrolytic copper refining, secondary copper, metallurgical acid plants. Final report, 15:33156 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 6. Primary tungsten, secondary tungsten and cobalt, primary molybdenum and rhenium, secondary molybdenum and vanadium. Final report, 15:33159 (R;US)
Oasis: Parameter estimation system for aquifer-restoration models. User's manual. Version 2.0. Report for October 1987-September 1989, 15:33149 (R;US)
Proximity of Delaware sanitary landfills to wetlands and deep-water habitats: Data on individual landfills. Part B, 15:33151 (R;US)
Proximity of Pennsylvania sanitary landfills to wetlands and deep-water habitats: Data on individual landfills, 15:33150 (R;US)
Sediment-water interactions and their effects upon water quality. January 1979-March 1990 (A Bibliography from the NTIS data base). Report for January 1979-March 1990, 15:33186 (R;US)
Toxicity bioassays: Water pollution effects on aquatic animals and plants. June 1986-February 1990 (A bibliography from the Selected Water Resources Abstracts data base). Report for June 1986-February 1990, 15:33183 (R;US)

WATER POLLUTION CONTROL
Pretreatment compliance monitoring and enforcement software. User's guide. version 2.0. Final report, 15:33168 (R;US)

WATER QUALITY
Comparison of hydrologic data from mined and unmined areas in the carbondale Group of Daviess, Pike, and Gibson Counties, Indana. Final report, 15:32100 (R;US)
Computerized data-base system for land-use and land-cover data collected at ground-water sampling sites in the pilot National Water-Quality Assessment Program. Water-Resources Investigation, 15:33152 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 2. Bauxite refining, primary aluminum smelting, secondary aluminum smelting. Final report, 15:33155 (R;US)
Evaluating direct toxicity and food-chain effects in aquatic systems using natural periphyton communities, 15:33139 (R;US)

WATER RESOURCES
A case study on optimal water management of small catchments: Aaros river in Norway, 15:32454 (R;NO)

WATER SUPPLY
Health assessment for Beachwood Borough and Berkeley Township National Priorities List (NPL) Site, Ocean County, New Jersey, Region 2. CERCLIS No. NJD980654123. Final report, 15:33142 (R;US)

WATER TABLES
Evaluations of the effects of the Columbia River on the unconfined aquifer beneath the 1301-N Liquid Waste Disposal Facility, 15:32232 (R;US)
Water levels in periodically measured wells in the Yucca Mountain Area, Nevada, 1988, 15:32240 (R;US)

WATERBORNE PARTICLES
See PARTICULATES

WAVE EQUATIONS
See also DIRAC EQUATION
KLEIN-GORDON EQUATION
SCHROEDINGER EQUATION
Validity and accuracy of multiple-scattering theory, 15:33643 (J;US)

WAVEGUIDES
Ion implantation of Ti into $LiNbO_3$: Fabrication of waveguides and simple modulators, 15:32995 (BA;US)

WAVES (SHOCK)
See SHOCK WAVES

WAZ 16
See NICKEL BASE ALLOYS

WEAK CHARGED CURRENTS
Prompt leptons from the decays of heavy quarks in the e^+e^- annihilation at energies of 35 and 43 GeV, 15:33408 (R;DE;In German)
WEAK INTERACTIONS
Completely ununified standard model, 15:33469 (J;US)
WEAR
Real-time bit-wear estimation using surface-vibration signals. Phase 1, 15:33007 (R;US)
WECS
See WIND TURBINES
WEINBERG ANGLE
Prompt leptons from the decays of heavy quarks in the e^+e^- annihilation at energies of 35 and 43 GeV, 15:33408 (R;DE;In German)
WEINBERG LEPTON MODEL
Electroweak BAU generation on the lattice: Real time vs. Euclidean approach, 15:33507 (R;DK)
WEINBERG MODEL
See WEINBERG LEPTON MODEL
WEINBERG-SALAM GAUGE MODEL
Anomaly-free left-right-symmetric models with gauged baryon and lepton numbers, 15:33466 (J;US)
Approximate computation of the small-fluctuation determinant around a sphaleron, 15:33517 (J;US)
WELDED JOINTS
A magnetographic technique for inspection of containment welds through coatings: Final report, 15:32337 (R;US)
Ambient-temperature creep failure of silver-aided diffusion bonds between steel, 15:32558 (R;US)
WELDS
See WELDED JOINTS
WELLS
See also GEOTHERMAL WELLS
INJECTION WELLS
OIL WELLS
Water levels in periodically measured wells in the Yucca Mountain Area, Nevada, 1988, 15:32240 (R;US)
WEST GERMANY
See FEDERAL REPUBLIC OF GERMANY
WEST VIRGINIA
Analysis of mutagenic activity of biohazardous organics in Kanawha River sediments. Technical completion report, 15:33181 (R;US)
WETLANDS
Cumulative impacts on water-quality functions of wetlands, 15:33173 (R;US)
Cumulative impacts on wetlands: Linking scientific assessments and regulatory alternatives, 15:33175 (R;US)
Evaluating cumulative effects of disturbance on the hydrologic function of bogs, fens, and mires, 15:33174 (R;US)
Strategies for assessing the cumulative effects of wetland alteration on water quality, 15:33172 (R;US)
Wetland areas: Natural water treatment systems. January 1978-August 1989 (a Bibliography from Pollution Abstracts). Report for January 1978-August 1989, 15:33182 (R;US)
WHISKERS
Electron microscopy of interfaces in silicon carbide whisker-reinforced alumina composites, 15:32699 (R;US)
WIGGLER MAGNETS
Spectral characteristics of insertion device sources at the Advanced Photon Source, 15:32932 (R;US)
WIND
Accuracy of wind measurements and international intercalibration of anemometers, 15:32304 (R;NL;In Dutch)
WIND ENERGY CONVERSION SYSTEMS
See WIND TURBINES
WIND FARMS
See WIND TURBINE ARRAYS
WIND GENERATORS
See WIND TURBINES
WIND LOADS
Wind turbine wake interference. A validation study. Vol. 1: Main text, 15:32302 (R;DK)
Wind turbine wake interference. A validation study. Vol. 2: Measurement results, 15:32303 (R;DK)
WIND POWER
Wind potential energy determination at Cammazes site, 15:32301 (R;FR;In French)
WIND TURBINE ARRAYS
Measurements at Aeroe Windmill park, 15:32307 (R;DK;In Danish)
Wake deficit measurements on the Jess and Souza Ranches, Altamont Pass, 15:32305 (R;US)
Wind turbine wake interference. A validation study. Vol. 1: Main text, 15:32302 (R;DK)
WIND TURBINES
Accuracy of wind measurements and international intercalibration of anemometers, 15:32304 (R;NL;In Dutch)
WIPP
Basic data report for drillhole H-12 (Waste Isolation Pilot Plant-WIPP), 15:32236 (R;US)
Geomechanical analyses in support of the Waste Isolation Pilot Plant (WIPP), 15:32237 (R;US)
WIRES
See also SUPERCONDUCTING WIRES
High-Speed Microphotographic Laboratory, 15:33013 (BA;US)
WOLFRAM
See TUNGSTEN
WOOD ALCOHOL
See METHANOL
WORKERS
See PERSONNEL
WWR-S-PRAGUE REACTOR
Determination of neutron flux densities in WWR-S reactor core, 15:32355 (R;CS;In Czech)
WWR-S-REZ REACTOR
See WWR-S-PRAGUE REACTOR
WYOMING
Integrated environmental monitoring at remote ecosystems: First annual report, 15:33124 (R;US)

X

X-2830 RESONANCES
See MESONS
X-RASERS
See X-RAY LASERS
X-RAY DETECTION
X-ray detection using the quantum well exciton nonlinearity, 15:33789 (J;US)
X-RAY EMISSION ANALYSIS
Electron-probe microanalysis: x-ray spectroscopy, 15:32786 (R;FR;In French)
X-RAY LASERS
High intensity short pulse generation at ILE Osaka University, 15:32936 (RA;JP)
Soft x-ray lasers, 15:32902 (J;US)
Spectrum and energy levels of six-times-ionized molybdenum (Mo VII), 15:33345 (J;US)
X-ray laser with enhanced x-ray gain through photodepopulation, 15:32905 (P;US)
X-RAY SOURCES
Development of high-power X-ray generation target for radiation processing, 15:32933 (R;JP;In Japanese)
Flash x-ray measurements with a time projection Compton spectrometer, 15:33009 (R;US)
X-ray preionization technology for high pressure gas discharge lasers, 15:32890 (BA;US)
X-RAY SPECTROSCOPY
A cell for extended x-ray absorption fine structure studies of oxygen sensitive products of redox reactions, 15:32984 (J;US)
X-ZERO RESONANCES
See ETA PRIME-958 MESONS
XANTHATES
Coal flotation and flocculation in the presence of humic acids, 15:32037 (RA;US)

XENOBIOTICS
Consolidated list of chemicals subject to reporting under the Emergency Planning and Community Right-To-Know Act: SARA (Superfund Amendments and Reauthorization Act of 1986) Section 302 Extremely Hazardous Substances, CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act) Hazardous Substances and SARA Section 313 Toxic Chemic, 15:32449 (R;US)
NIOSH (National Institute for Occupational Safety and Health) testimony on indoor air quality by J. Melius on August 3, 1983, 15:33077 (R;US)
Roadmaps to sources of information on chemicals listed in the Emergency Planning Community and Community Right-To-Know Act also known as SARA (Superfund Amendments and Reauthorization Act) Title III, Section 313. Toxic Release Inventory (for microcomputers). Data file, 15:33095 (R;US)
Toxicity bioassays: Water pollution effects on aquatic animals and plants. June 1986-February 1990 (A bibliography from the Selected Water Resources Abstracts data base). Report for June 1986-February 1990, 15:33183 (R;US)

XENON
Collisional relaxation of the $6s[3/2]_1^0$ and $6s'[1/2]_1^0$ m_J levels of xenon using resonantly enhanced multiphoton ionization, 15:33372 (J;US)
Generation of optical harmonics by intense pulses of laser radiation. II. Single-atom spectrum for xenon, 15:33352 (J;US)
Melting and orientational epitaxy in argon and xenon monolayers on graphite, 15:32776 (J;US)
Precipitation of Ar, Kr and Xe in Ni at room temperature, 15:32730 (BA;US)
Search for a multiproperty empirical intermolecular potential for $XeSF_6$, 15:32817 (J;US)

XENON 132
Decay of ^{132}Cs and nuclear structure of ^{132}Xe, 15:33541 (R;BR)

XENON IONS
In situ HVEM study of ion irradiation-induced grain growth in Au thin films, 15:32725 (BA;US)

XENOTIME
Bubble attachment time measurements for selected rare-earth phosphate minerals in oleate solutions, 15:32798 (BA;US)

XI NEUTRAL
See XI NEUTRAL PARTICLES

XI NEUTRAL PARTICLES
Branching ratio and asymmetry for $\Xi^0 \rightarrow \Lambda\gamma$, 15:33414 (J;US)

XI-NEUTRAL
See XI NEUTRAL PARTICLES

XYLENES
Modification of coal surfaces with methyl radicals, 15:32057 (RA;US)

XYLENOLS
Production of jet fuels from coal derived liquids: Volume 6, Preliminary analysis of upgrading alternatives for the Great Plains liquid by-product streams: Interim report, March 1987–February 1988, 15:32058 (R;US)

Y

Y*RESONANCES
See BARYONS

Y-12 PLANT
Management information systems for environmental compliance activities, 15:32205 (R;US)

YANG-MILLS THEORY
Wormhole solution in coupled Yang-Mills–axion system, 15:33518 (J;US)

YIELD (BIOLOGICAL)
See PRODUCTIVITY

YTTERBIUM
Hanle effect in spectrally broadened light, 15:33380 (J;US)

YTTERBIUM 151
Single-particle states in ^{151}Tm and ^{151}Er: Systematics of neutron states in N=83 nuclei, 15:33551 (J;US)

YTTERBIUM ALLOYS
Neutron scattering experiments on $YbXCu_4$ and $ErXCu_4$ (X=Au, Pd, and Ag), 15:32591 (J;US)

YTTRIUM
Dynamical information for Fe doped $YBa_2Cu_3O_7$ superconducting oxides obtained from high temperature Moessbauer studies, 15:32602 (R;BR)

YTTRIUM 100
Subnanosecond lifetime measurements in Y and Sr nuclei and the saturation of deformation near A=100, 15:33546 (J;US)

YTTRIUM 96
Meson-exchange enhancement of the first-forbidden $^{96}Y^g(0^-) \rightarrow {}^{96}Zr^g$ (0^+) β transition: β decay of the low-spin isomer of ^{96}Y, 15:33543 (J;US)

YTTRIUM 97
Coexistence features in the spherical-deformed $A \approx 100$ transition region: Picosecond lifetime measurements in ^{97}Sr, ^{97}Y, and ^{97}Zr, 15:33545 (J;US)

YTTRIUM 98
Subnanosecond lifetime measurements in Y and Sr nuclei and the saturation of deformation near A=100, 15:33546 (J;US)

YTTRIUM ADDITIONS
Structure maps and phase stability in $AlTi_3$ alloyed with rare-earth elements, 15:32562 (BA;US)

YTTRIUM ALUMINIUM GARNETS
See ALUMINIUM OXIDES
YTTRIUM COMPOUNDS

YTTRIUM COMPOUNDS
See also YTTRIUM NITRATES
YTTRIUM OXIDES
Development of a large scale Nd:YAG growth process, 15:32884 (R;US)
Effects of shock-induced defects on flux pinning in $YBa_2Cu_3O_{7-\delta}$, 15:32899 (BA;US)
Elastic constants of two $Y_1Ba_2Cu_3O_x$ superconductors: x = 6.70 and 6.92, 15:32892 (BA;US)
Radiation induced amorphization in $YBa_2Cu_3O_7$ and $GdBa_2Cu_3O_7$ superconductors, 15:32896 (BA;US)

YTTRIUM NITRATES
Microencapsulation of silicon nitride particles with yttria and yttria-alumina precursors, 15:32668 (J;US)

YTTRIUM OXIDES
Antiferromagnetism
Magnetic ordering in $(Y_{1-x}Pr_x)Ba_2Cu_3O_7$ as observed by muon-spin relaxation, 15:32693 (J;US)
Chemical Reactions
High T_c oxide solid state reaction kinetics via complex impedance spectroscopy, 15:32802 (R;US)
Critical Field
Temperature dependence of the lower critical field of single crystal $YBa_2Cu_3O_{7-\delta d}$, 15:32655 (BA;US)
Electron Microscopy
$\delta^2 - Y_2Si_2O_7$ structure confirmed by processing and simulaton of atomic-resolution images, 15:32636 (BA;US)
Energy Beam Deposition
YBCO films on YSZ and Al_2O_3 by pulsed laser deposition, 15:32631 (BA;US)
Holes
O 2p holes: Temperature effects and surface characteristics of cuprate superconductors, 15:32689 (J;US)
Josephson Effect
Interlayer coupling in high temperature superconductors, 15:32647 (BA;US)
Light Transmission
Infrared synchrotron-radiation transmission measurements on $YBa_2Cu_3O_{7-\delta}$ in the gap and supercurrent regions, 15:32691 (J;US)
Magnetic Flux
Observation of thermally activated flux motion inweak link structures, 15:32656 (BA;US)
Magnetoresistance
Flux-flow resistivity in single crystal $YBa_2Cu_3O_{7-\delta}$, 15:32654 (BA;US)

Nmr Spectra
17$_{ONMR}$ study of $YBaa_2Cu_3O_{7-\delta}$, 15:32658 (BA;US)
Nuclear Quadrupole Resonance
Calculation of the nuclear quadrupole resonance spectra of $YBa_2Cu_3O_{7-x}$, 15:32640 (BA;US)
Physical Properties
Calcium-substituted Y-Ba-Cu-O superconductors with enhanced T_c synthesized at elevated oxygen pressures, 15:32686 (J;US)
Superconducting thin films of YBaCu oxides prepared by MOCVD, 15:32607 (R;US)
Sintering
Rapid thermal processing of high temperature superconducting fiber, 15:32616 (R;US)
Specific Heat
Effect of Cu^{2+} magnetic moments on the superconductivity of $YBa_2Cu_3O_7$: The origin of the "linear term" in the specific heat; The volume fraction of superconductivity, 15:32613 (R;US)
Stacking Faults
Effects of deformation on shielding currents in $YBa_2Cu_3O_{7-\delta}$, 15:32650 (BA;US)
Superconducting Films
Surface resistance of $YBa_2Cu_3O_7$ films deposited on $LaGaO_3$ substrates, 15:32900 (BA;US)
Superconductivity
Evidence for a charge-density wave or spin-density wave in the Cu-O chains in $YBa_2Cu_3O_{7-x}$, 15:32678 (J;US)
Processing chemically prepared $YBa_2Cu_3O_7$ precursor powders, 15:32898 (BA;US)
Superconducting properties of grain boundaries in dense, fine grained $YBa_2Cu_3O_x$, 15:32660 (BA;US)
Superconductors
The production of high performance $YBa_2Cu_3O_7$ using nitrogen dioxide, 15:32666 (J;US)
Transition Temperature
Magnetic and pairing correlations in a three band Hubbard model, 15:32646 (BA;US)
YUCCA MOUNTAIN
Water levels in periodically measured wells in the Yucca Mountain Area, Nevada, 1988, 15:32240 (R;US)

Z

Z NEUTRAL BOSONS
Search for long-lived massive neutrinos in *Z* decays, 15:33415 (J;US)
Weak-boson production by charm quarks, 15:33421 (J;US)
Z-boson decays to heavy quarkonium, 15:33463 (J;US)
ZEA MAYS
See MAIZE
ZEOLITES
Multicomponent ion-exchange equilibria in chabazite zeolite, 15:32203 (R;US)
ZET PINCH
See LONGITUDINAL PINCH
ZINC
Concentrations of metals in Norton Sound seawater samples and human hair samples, 1989, 15:33188 (R;US)
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 4. Primary zinc, primary lead, secondary lead, primary antimony. Final report, 15:33157 (R;US)
National Performance Audit Program: Acid rain audits, 1988, 15:33082 (R;US)
Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the Salton Sea Area, California, 1986-87. Water-Resources investigation, 15:33164 (R;US)
ZINC 64 TARGET
High-spin structure of N=51 ^{96}Rh and ^{97}Pd: A shell-model study, 15:33548 (J;US)
ZINC IONS
Correlation enhancement of the electron-impact ionization cross section for excited-state Ne-like ions, 15:33370 (J;US)
ZINC OXIDES
Nitrogen doping of ZnO prepared by organometallic chemical vapor deposition, 15:32642 (BA;US)
Review, discussion, and summary: Toxicology, 15:33248 (R;US)
ZINC SULFIDES
Laser damage studies of ZnS via neutral Zn particle emission, 15:32748 (J;US)
ZINC TELLURIDES
Band-gap narrowing in ordered and disordered semiconductor alloys, 15:32750 (J;US)
Interfacial chemistry of metals on CdTe and ZnTe (110), 15:32757 (J;US)
ZINC-AIR BATTERIES
Initial testing of two DEMI [Driesbach Electromotive Inc.] Model 4E zinc-air rechargeable cells, 15:32439 (R;US)
ZIRCALOY
See also ALLOY-ZR98SN-4
Internal hydriding in irradiated defected Zircaloy fuel rods, 15:32572 (BA;US)
ZIRCALOY 4
Beta-quenched Zircaloy-4: Effects of thermal aging and neutron irradiation, 15:32583 (BA;US)
ZIRCONIUM
Development document for effluent-limitations guidelines and standards for the nonferrous-metals-manufacturing point source category. Volume 9. Primary and secondary titanium, primary zirconium and hafnium. Final report, 15:33161 (R;US)
Spectroscopic properties of 34 electronic states of zirconium dimer (Zr_2), 15:33383 (J;US)
ZIRCONIUM 100
Monopole strength and shape coexistence in the $A \approx 100$ mass region, 15:33544 (J;US)
ZIRCONIUM 96
Meson-exchange enhancement of the first-forbidden $^{96}Y^g(0^-) \rightarrow {}^{96}Zr^g$ (0^+) β transition: β decay of the low-spin isomer of ^{96}Y, 15:33543 (J;US)
ZIRCONIUM 97
Coexistence features in the spherical-deformed $A \approx 100$ transition region: Picosecond lifetime measurements in ^{97}Sr, ^{97}Y, and ^{97}Zr, 15:33545 (J;US)
ZIRCONIUM ALLOYS
See also ZIRCONIUM BASE ALLOYS
Microstructure and mechanical properties of Ll_2-structure alloys based on Al_3Zr, 15:32576 (BA;US)
ZIRCONIUM BASE ALLOYS
See also ZIRCALOY
Amorphization of Zr_3Al by hydrogenation and subsequent electron irradiation, 15:32574 (BA;US)
Study of metal corrosion using ac impedance techniques in the STS launch environment, 15:32549 (RA;US)
ZIRCONIUM OXIDES
Friction and wear of whisker-reinforced ceramic composite bodies, 15:32609 (R;US)
YBCO films on YSZ and Al_2O_3 by pulsed laser deposition, 15:32631 (BA;US)

Contract Number Index

Numbers assigned to DOE contracts announced in documents in this publication are listed. Contract numbers are sorted alphanumerically and list the primary corporate author of the document cited, the citation number, and the report number or other document identification.

Contract No.	Abstract No.	Report No.
AC01-88DP50066	**Pacific-Sierra Research Corp., Arlington, VA (USA)**	
	15:32528	PSR–1952
AC02-76CH00016	**Argonne National Lab., IL (USA)**	
	15:33047	BNL–44496
	Brookhaven National Lab., Upton, NY (USA)	
	15:32199	BNL–43691
	15:32200	BNL-NUREG–44506
	15:32266	BNL–44410
	15:32462	BNL–44454
	15:32906	BNL–44466
	15:32907	BNL–44606
	15:32920	BNL–44583
	15:32930	BNL–43273
	15:32931	BNL–43413
	15:33116	BNL–43811-Rev.
	15:33212	BNL–44536
	15:33562	BNL–44522
	15:32588	Published article
	15:32594	Published article
	15:32601	Published article
	15:32676	Published article
	15:32684	Published article
	15:32691	Published article
	15:32742	Published article
	15:32756	Published article
	15:32776	Published article
	15:32982	Published article
	15:32984	Published article
	15:33464	Published article
	15:33471	Published article
	15:33545	Published article
	15:33546	Published article
	15:33591	Published article
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	15:33290	FERMILAB-PUB–90/69-A
	15:33291	FNAL/Pub–90/56-A
AC02-76CH03073	**Princeton Univ., NJ (USA). Plasma Physics Lab.**	
	15:33785	PPPL–2666
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AC02-76ER00038	**Notre Dame Univ., IN (USA)**	
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AC02-76ER13065	**Rochester Univ., NY (USA). Dept. of Physics and Astronomy**	
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AC02-80RA50219	**Southwest Research Inst., San Antonio, TX (USA)**	
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AC02-83CH10093	**Solar Energy Research Inst., Golden, CO (USA)**	
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Contract No.	Abstract No.	Report No.
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	15:33062	MHSMP–89-27
AC04-76DP00613	Allied-Signal Aerospace Co., Kansas City, MO (USA). Kansas City Div.	
	15:33848	KCP–613-4215
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	15:32415	NUREG/CR–4550-Vol.3-Rev.1-Pt.2
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Contract No.	Abstract No.	Report No.
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	15:32118	SAND–90-8223
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AC04-76EV01013	**Lovelace Biomedical and Environmental Research Inst., Albuquerque, NM (USA). Inhalation Toxicology Research Inst.**	
	15:33223	LMF–121
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AC05-76ER01067		
	15:32958	CONF-890703–
AC05-76OR00033	**Oak Ridge Associated Universities, Inc., TN (USA)**	
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	15:32333	ORNL/M–1073
	15:32356	CONF-9006173–1
	15:32429	CONF-9005172–1
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	15:32536	CONF-900466–34
	15:32537	CONF-900466–37
	15:32538	CONF-900623–7
	15:32542	CONF-900774–1
	15:32553	ORNL/FTR–3606
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	15:33119	CONF-900758–1
	15:33139	CONF-9004197–1
	15:33192	CONF-900512–1
	15:33215	CONF-900512–2
	15:33225	ORNL/FTR–3600
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	15:33328	CONF-8906270–5
	15:33529	ORNL/FTR–3613
	15:33566	CONF-881054–49
	15:33616	CONF-900582–1
	15:33723	ORNL/TM–11356
	15:33806	CONF-900505–2
	15:33807	CONF-900519–1
	15:33842	CONF-9004159–7
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	15:33597	Published article
	15:33639	Published article
	15:33640	Published article
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	15:33794	Published article
AC05-84OT21400	**Oak Ridge Gaseous Diffusion Plant, TN (USA)**	
	15:33060	K/QT–222
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AC06-76RL01830	**Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research**	
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	15:33101	PNL–6415-Rev.2
	15:33102	PNL–6450-30-HEDR
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	15:32419	NUREG/CR–5397
	15:32815	Published article
AC06-84RL10436	**Golder Associates, Inc., Bellevue, WA (USA)**	
	15:32206	DOE/NBB–0071-Vol.1
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	15:32208	DOE/NBB–0071-Vol.3
AC06-87RL10930	**Westinghouse Hanford Co., Richland, WA (USA)**	
	15:32262	WHC-SA–0881
	15:33135	WHC-EP–0359
	USDOE Richland Operations Office, WA (USA)	
	15:32209	DOE/RL–88-04-Rev.2
AC07-76ID01570	**Oak Ridge National Lab., TN (USA)**	
	15:33807	CONF-900519–1
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	15:32407	NUREG/CP–0104
	EG and G Idaho, Inc., Idaho Falls, ID (USA)	
	15:32066	EGG-M–89151
	15:32067	EGG-M–89221
	15:32190	EGG-M–88503
	15:32215	EGG-M–89251
	15:32216	EGG-M–89464
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	15:32298	EGG-EP–9029
	15:32319	EGG-M–88444
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	15:32346	EGG-M–90151
	15:32347	EGG-NPD–8836
	15:32348	EGG-NPD–8837
	15:32358	EGG-M–89106
	15:32359	EGG-M–89113
	15:32360	EGG-M–89114
	15:32362	EGG-M–89329
	15:32363	EGG-M–89393
	15:32364	EGG-M–89412
	15:32438	EGG-EP–8919
	15:32439	EGG-EP–8954
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	15:32523	EGG-M–90200
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	15:32785	EGG-M–89267
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	15:33125	EGG-ER–8686
	15:33222	EGG-BNCT–8777-Vol.4-No.3
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	15:32350	EGG-M–89074
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	EG and G Idaho, Inc., Idaho Falls, ID (USA). Center for Environmental Monitoring and Assessment	
	15:33124	EGG-CEMA–8185
AC07-81NE44139	**West Valley Nuclear Services Co., Inc., West Valley, NY (USA)**	
	15:32243	WVDP–90AR
AC07-86ID12735	**MSE, Inc., Butte, MT (USA)**	
	15:32474	DOE/ID/12735–T8
AC08-88NV10617	**Christian Michelsens Inst. for Vitenskap og Aandsfrihet, Bergen (Norway)**	
	15:32144	EGG–10617-1058
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	Colorado State Univ., Fort Collins, CO (USA)	
	15:32143	EGG–10617-1057
	EG and G Idaho, Inc., Idaho Falls, ID (USA)	
	15:32973	EGG–10617-2066
	EG and G Energy Measurements, Inc., Las Vegas, NV (USA)	
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	EG and G Energy Measurements, Inc., Las Vegas, NV (USA). Remote Sensing Lab.	
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	15:32139	EGG–10617-1054
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AC08-89NV10630	**Reynolds Electrical and Engineering Co., Inc., Las Vegas, NV (USA). Technical Information Dept.**	
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AC09-89SR18035	**Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.**	
	15:32214	DPST–82-492
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Contract No.	Abstract No.	Report No.
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AC21-85MC21353	EG and G Washington Analytical Services Center, Inc., Morgantown, WV (USA)	
	15:32049	DOE/MC/21353--2805
AC21-85MC22065	SRI International, Menlo Park, CA (USA)	
	15:32050	DOE/MC/22065--2809
AC21-87MC24267	North Dakota Univ., Grand Forks, ND (USA). Energy and Environmental Research Center	
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AC21-88MC25009	Energy Research Corp., Danbury, CT (USA)	
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AC22-87PC90015	Amoco Oil Co., Naperville, IL (USA). Research and Development Dept.	
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	15:32062	DOE/PC/90015--T5
	15:32063	DOE/PC/90015--T6
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AC96-78PO07196	Parsons, Brinckerhoff, Quade and Douglas, Inc., New York, NY (USA)	
	15:32160	DOE/PO/07196--T2
	PB/KBB, Harahan, LA (USA)	
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AC96-82PO10391	York Research Consultants, Denver, CO (USA)	
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FC21-86MC11076	Western Research Inst., Laramie, WY (USA)	
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FC22-89PC89904	Southern Illinois Univ., Carbondale, IL (USA). Coal Extraction and Utilization Research Center	
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FG02-84ER13247		
	15:32824	Published article
FG02-84ER13255	Washington Univ., St. Louis, MO (USA)	
	15:33193	DOE/ER/13255--6
FG02-84ER13261		
	15:32827	Published article
FG02-84ER13282	Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Chemical Engineering	
	15:32835	CONF-900704--9
FG02-84ER40158		
	15:33318	Published article
	15:33512	Published article
FG02-84ER40173		
	15:33463	Published article
FG02-84ER45082		
	15:32759	Published article
FG02-84ER45125		
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FG02-84ER45167	Brown Univ., Providence, RI (USA). Div. of Engineering	
	15:32608	CONF-900764--1
	15:32610	DOE/ER/45167--2
FG02-84ER45170		
	15:32696	Published article
FG02-85ER13370	Cornell Univ., Ithaca, NY (USA). Dept. of Microbiology	
	15:32267	DOE/ER/13370--1
FG02-85ER13441		
	15:33646	Published article
FG02-85ER40213		
	15:33516	Published article
FG02-85ER40231		
	15:33458	Published article
FG02-85ER45183		
	15:32742	Published article

Contract No.	Abstract No.	Report No.
FG02-85ER45189		
	15:33638	Published article
FG02-85ER45214		
	15:33648	Published article
FG02-85ER53198	Wisconsin Univ., Madison, WI (USA). Dept. of Physics	
	15:33810	DOE/ER/53198–154
FG02-85ER60372	Columbia Univ., Palisades, NY (USA). Lamont-Doherty Geological Observatory	
	15:33054	DOE/ER/60372–5
FG02-86ER13542	Delaware Univ., Newark, DE (USA). Dept. of Chemistry	
	15:32784	DOE/ER/13542–4
FG02-86ER13553	Massachusetts Inst. of Tech., Cambridge, MA (USA)	
	15:32861	CONF-900704–7
FG02-86ER13558		
	15:33383	Published article
FG02-86ER13631	Arizona Univ., Tucson, AZ (USA). Dept. of Biochemistry	
	15:32279	DOE/ER/13631–17
FG02-86ER40304	City Coll., New York, NY (USA). Dept. of Physics	
	15:33530	DOE/ER/40304–6
FG02-86ER45250		
	15:32772	Published article
FG02-86ER45254		
	15:32768	Published article
FG02-86ER53214		
	15:33799	Published article
FG02-86ER53222	Columbia Univ., New York, NY (USA). Dept. of Applied Physics	
	15:33733	DOE/ER/53222–102
FG02-86ER53236	Grumman Aerospace Corp., Princeton, NJ (USA). Corporate Research Center	
	15:33734	DOE/ER/53236–T2
FG02-86ER60448		
	15:33204	Published article
FG02-87ER13700		
	15:32839	Published article
FG02-87ER13729	Michigan State Univ., East Lansing, MI (USA)	
	15:33194	DOE/ER/13729–2
FG02-87ER13799		
	15:33283	Published article
FG02-87ER25026	Illinois Univ., Urbana, IL (USA). Dept. of Computer Science	
	15:33844	DOE/ER/25026–35
FG02-87ER40315	Carnegie-Mellon Univ., Pittsburgh, PA (USA). Dept. of Physics	
	15:33434	DOE/ER/40315–T1
FG02-87ER40328		
	15:33514	Published article
	15:33517	Published article
FG02-87ER40370		
	15:33587	Published article
FG02-87ER45297		
	15:32692	Published article
FG02-87ER45302		
	15:32588	Published article
FG02-87ER45305		
	15:32745	Published article
FG02-87ER45333		
	15:33659	Published article
FG02-87ER45334		
	15:33651	Published article
FG02-87ER53257		
	15:33797	Published article
FG02-88ER13933	Pittsburgh Univ., PA (USA). Dept. of Chemistry	
	15:33617	DOE/ER/13933–T1
FG02-88ER13942	Bowling Green State Univ., OH (USA)	
	15:32825	DOE/ER/13942–2
FG02-88ER13955		
	15:33360	Published article
	15:33367	Published article
FG02-88ER13969		
	15:32801	Published article
FG02-88ER40388		
	15:33584	Published article
FG02-88ER40404		
	15:33542	Published article
FG02-88ER40417		
	15:33545	Published article
FG02-88ER45341	Columbia Univ., New York, NY (USA). Henry Krumb School of Mines	
	15:32611	DOE/ER/45341–3
FG02-88ER45356	Johns Hopkins Univ., Baltimore, MD (USA). Dept. of Chemical Engineering	
	15:32860	CONF-900704–6
FG02-88ER45373	Notre Dame Univ., IN (USA)	
	15:33618	DOE/ER/45373–2
FG02-88ER53254		
	15:33796	Published article
	15:33834	Published article
FG02-88ER60664	Rogers and Associates Engineering Corp., Salt Lake City, UT (USA)	
	15:33140	DOE/ER/60664–5
FG02-89ER14004	Ohio State Univ. Research Foundation, Columbus, OH (USA)	
	15:33195	DOE/ER/14004–1
FG02-89ER14011	Johns Hopkins Univ., Baltimore, MD (USA). Dept. of Biology	
	15:33211	DOE/ER/14011–1
FG03-84ER13240		
	15:33391	Published article
FG03-84ER45156		
	15:32760	Published article
FG03-86ER13595	California State Univ., Long Beach, CA (USA). Long Beach Foundation	
	15:33720	DOE/ER/13595–T1
FG03-86ER45230		
	15:32670	Published article
	15:32694	Published article
	15:32761	Published article
FG03-87ER13752		
	15:32929	Published article
FG03-87ER45332		
	15:32598	Published article
FG03-87ER60504		
	15:33348	Published article
	15:33372	Published article
FG03-87ER60548		
	15:33208	Published article
FG03-89ER14048		
	15:32820	Published article
FG04-87AL44658	Lawrence Livermore National Lab., CA (USA)	
	15:32789	UCRL–102494
FG05-80ET53088	Texas Univ., Austin, TX (USA). Inst. for Fusion Studies	
	15:33737	DOE/ET/53088–432
	15:33795	Published article
FG05-85ER13435	Georgia Inst. of Tech., Atlanta, GA (USA). School of Chemistry	
	15:32783	DOE/ER/13435–4
FG05-85ER40215		
	15:33467	Published article
FG05-86ER13482		
	15:33389	Published article
FG05-86ER13591	Tennessee Univ., Knoxville, TN (USA). Dept. of Chemistry	
	15:32702	DOE/ER/13591–4

Contract No.	Abstract No.	Report No.
FG05-86ER40272		
	15:33519	Published article
FG05-86ER40299		
	15:33580	Published article
FG05-86ER53217	**Oak Ridge National Lab., TN (USA)**	
	15:33328	CONF-8906270–5
FG05-86ER60473		
	15:33201	Published article
FG05-87ER40322		
	15:33589	Published article
FG05-87ER40361		
	15:33595	Published article
FG05-87ER45316		
	15:33365	Published article
FG05-87ER52147	**Maryland Univ., College Park, MD (USA)**	
	15:33732	DOE/ER/52147–3
	15:33808	DOE/ER/52147–T1
	15:33809	DOE/ER/52147–T2
FG05-88ER13902		
	15:33396	Published article
FG05-88ER13950	**North Carolina Univ., Chapel Hill, NC (USA). Dept. of Chemistry**	
	15:32804	DOE/ER/13950–2
FG05-88ER40407		
	15:33595	Published article
FG05-88ER40442		
	15:32958	CONF-890703–
FG05-88ER40461		
	15:33594	Published article
FG05-88ER53266	**Texas Univ., Austin, TX (USA). Fusion Research Center**	
	15:33735	DOE/ER/53266–32
FG05-88ER53267	**Texas Univ., Austin, TX (USA). Fusion Research Center**	
	15:33811	DOE/ER/53267–3
FG05-89ER53295	**Texas Univ., Austin, TX (USA). Fusion Research Center**	
	15:33736	DOE/ER/53295–1
FG05-89ER60871	**Applied Research Corp., Landover, MD (USA)**	
	15:33213	DOE/ER/60871–1
FG06-85ER40224		
	15:33461	Published article
FG06-87ER45287		
	15:32587	Published article
FG07-88ID12756	**Utah Geological and Mineral Survey, Salt Lake City, UT (USA)**	
	15:32295	DOE/ID/12756–1
FG09-88SR18047	**Savannah State Coll., GA (USA). Dept. of Chemistry**	
	15:32092	DOE/SR/18047–2
FG21-87MC24051	**West Virginia Univ., Morgantown, WV (USA). Coll. of Engineering**	
	15:32172	DOE/MC/24051–2808
FG22-87BC14126	**Stanford Univ., CA (USA). Petroleum Research Inst.**	
	15:32129	DOE/BC/14126–18
FG22-88BC14230	**Interstate Oil Compact Commission, Oklahoma City, OK (USA)**	
	15:32147	DOE/BC/14230–T4
FG22-88PC88913	**University of Southern California, Los Angeles, CA (USA). Dept. of Mechanical Engineering**	
	15:32114	DOE/PC/88913–T5
FG22-88PC88917	**Florida Univ., Gainesville, FL (USA). Mineral Resources Research Center**	
	15:32052	DOE/PC/88917–T4
FG22-88PC88934	**Pennsylvania State Univ., University Park, PA (USA)**	
	15:32083	DOE/PC/88934–T5
FG22-88PC88935	**Pennsylvania State Univ., University Park, PA (USA). Coll. of Earth and Mineral Sciences**	
	15:32053	DOE/PC/88935–T5
W-31-109-ENG-38	**Argonne National Lab., IL (USA)**	
	15:33607	ANL-Trans–89-52
	15:32748	CONF-8810399–
	15:32428	Published article
W-31109-ENG-38	**Argonne National Lab., Idaho Falls, ID (USA)**	
	15:32326	CONF-900418–15
	Argonne National Lab., IL (USA)	
	15:32097	CONF-9004110–2
	15:32112	CONF-900546–2
	15:32202	CONF-900676–4
	15:32253	CONF-9004181–2
	15:32277	CONF-891098–3
	15:32318	CONF-9004133–3
	15:32321	CONF-900789–2
	15:32442	CONF-9004182–1
	15:32473	CONF-9006105–1
	15:32502	CONF-900102–5
	15:32513	CONF-900676–5
	15:32525	CONF-9002120–1
	15:32539	CONF-900623–8
	15:32540	CONF-900623–9
	15:32541	CONF-900623–10
	15:32604	CONF-900432–1
	15:32606	CONF-900634–1
	15:32607	CONF-900709–1
	15:32780	CONF-900402–7
	15:32781	CONF-900704–10
	15:32802	CONF-891119–132
	15:32803	CONF-8908191–3
	15:32862	CONF-9005168–1
	15:32878	ANL–89/35
	15:32932	CONF-9003154–2
	15:33137	ANL–90/7
	15:33221	CONF-8910367–2
	15:33327	CONF-900190–1
	15:33615	CONF-900466–38
	15:33731	CONF-8909331–1
	15:33804	CONF-891007–120
	15:33805	CONF-891204–33
	15:33840	CONF-900765–1
	15:33841	CONF-900793–1
	15:33843	CONF-9006169–2
	15:32479	CONF-870811–Vol.2
	Argonne National Lab., IL (USA). High Energy Physics Div.	
	15:32966	ANL-HEP-CP–90-33
	15:32967	ANL-HEP-CP–90-34
	Argonne National Lab., IL (USA). Environment, Safety, and Health Dept.	
	15:33114	ANL/ESH/TS–90/101
	15:33115	ANL/ESH/TS–90/103
	Argonne National Lab., Washington, DC (USA)	
	15:33048	CONF-900676–6
	Argonne National Lab., IL (USA). Environmental Assessment and Information Sciences Div.	
	15:32470	ANL/EAIS/TM–10
	Argonne National Lab., IL (USA). Energy Systems Div.	
	15:32499	ANL/ESD–3
	Argonne National Lab., IL (USA). Advanced Photon Source Accelerator Systems Div.	
	15:32919	ANL/APS-TM–5
	15:32928	CONF-890703–
	15:32598	Published article

Contract No.	Abstract No.	Report No.
	15:32673	Published article
	15:32675	Published article
	15:32681	Published article
	15:32687	Published article
	15:32688	Published article
	15:32775	Published article
	15:32818	Published article
	15:33384	Published article
	15:33420	Published article
	15:33422	Published article
	15:33534	Published article
	15:33581	Published article
	15:33583	Published article
	15:33590	Published article
	15:33634	Published article
	15:33635	Published article
	15:33657	Published article
W-7405-ENG-36	**Sandia National Labs., Albuquerque, NM (USA)**	
	15:32616	SAND-90-1229C
	15:33632	SAND-90-1265C
	Los Alamos National Lab., NM (USA)	
	15:32258	LA-UR-90-1372
	15:32265	LA-UR-90-753
	15:32453	LA-11765-MS
	15:32548	LA-11762-MS
	15:32806	LA-UR-90-1338
	15:32852	LA-UR-90-1333
	15:33040	LA-11743-MS
	15:33041	LA-11776-MS
	15:33061	LA-UR-90-1332
	15:33214	LA-UR-90-1438
	15:33234	LA-UR-90-1329
	15:33820	LA-11808-C
	15:33849	LA-UR-90-771
W-7405-ENG-48	**Lawrence Livermore National Lab., CA (USA)**	
	15:32167	UCRL-102497-1
	15:32186	UCID-16986-89-2/3/4
	15:32239	UCRL-100211
	15:32297	UCRL-100841
	15:32497	UCRL-102927
	15:32519	UCRL-102495
	15:32520	UCRL-102496
	15:32529	UCRL-52000-90-3
	15:32530	UCRL-ID-103480
	15:32558	UCRL-101690
	15:32714	UCRL-100808
	15:32715	UCRL-102758
	15:32716	UCRL-JC-103630
	15:32808	UCRL-JC-103872
	15:32836	UCRL-102584
	15:32837	UCRL-102778
	15:32884	UCRL-102201
	15:32885	UCRL-102667
	15:32887	UCRL-JC-103302
	15:32940	UCRL-102623
	15:32941	UCRL-102982
	15:32942	UCRL-102983
	15:32943	UCRL-102986
	15:32944	UCRL-102987
	15:32961	UCID-21937
	15:32979	UCRL-101659
	15:32980	UCRL-ID-103470
	15:33029	UCRL-102393
	15:33030	UCRL-102395
	15:33031	UCRL-102578
	15:33032	UCRL-JC-103244
	15:33033	UCRL-JC-103512
	15:33034	UCRL-JC-103626
	15:33038	UCRL-ID-103766
	15:33039	UCRL-JC-103498
	15:33044	UCRL-101292
	15:33103	UCRL-101735
	15:33104	UCRL-101997
	15:33105	UCRL-101998
	15:33106	UCRL-102785
	15:33107	UCRL-JC-103431
	15:33108	UCRL-JC-103591
	15:33109	UCRL-JC-103969
	15:33134	UCRL-21221
	15:33196	UCRL-102985
	15:33386	UCRL-ID-103271
	15:33387	UCRL-ID-103611
	15:33388	UCRL-JC-103579
	15:33451	UCRL-JC-103865
	15:33787	UCRL-ID-103473
	15:33823	UCID-21849-Rev.1
	15:33824	UCRL-ID-103486
	15:33854	UCRL-102737-Rev.1
	15:33855	UCRL-ID-103202
	15:32789	UCRL-102494
	15:33001	UCRL-CR-103263
	15:33037	UCRL-21239
	15:33230	UCRL-21223-App.
	Kaman Sciences Corp., Santa Monica, CA (USA). Dikewood Div.	
	15:32886	UCRL-CR-103860
	15:32674	Published article
	15:32748	CONF-8810399-
	15:32765	Published article
	15:32767	Published article
	15:33324	Published article
	15:33352	Published article
	15:33359	Published article
	15:33373	Published article
	15:33374	Published article
	15:33379	Published article
	15:33390	Published article
	15:33547	Published article
	15:33558	Published article
	15:33582	Published article
	15:33588	Published article
W-7405-ENG-82		
	15:32593	Published article
	15:32747	Published article
	15:32751	Published article
	15:32773	Published article
	15:33385	Published article
	15:33545	Published article
	15:33641	Published article
	15:33650	Published article
	15:33658	Published article

Report Number Index

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Report Number	*Abstract Number*	*Source of Availability*	*GPO Dep.*	*Order Number*	*Distribution Category*
AD-A–					
217161/9/XAB	15:33024	NTIS, PC A04/MF A01			
217408/4/XAB	15:33857	NTIS, PC A05/MF A01			
217445/6/XAB	15:32128	NTIS, PC A05/MF A01			
AFIT/CI/CIA–					
89-097	15:32128	*See* AD-A–217445/6/XAB			
AFME–					
83.1175	15:32268	NTIS (US Sales Only), PC A06/MF A01		DE90790628	
85.05.1016	15:32275	NTIS (US Sales Only), PC A11/MF A01		DE90790625	
85.06.1017	15:32301	NTIS (US Sales Only), PC A03/MF A01		DE90790626	
AFME-FR–					
11	15:32498	NTIS (US Sales Only), PC A04/MF A01		DE90790632	
AFWAL-TR–					
87-2042-Vol.12	15:32060	*See* DOE/PC/90015–T1-Vol.12			
87-2042-Vol.6	15:32058	*See* DOE/PC/90015–T1-Vol.6			
87-2042-Vol.9	15:32059	*See* DOE/PC/90015–T1-Vol.9			
ALS/TR–					
90-008	15:33002	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011046	MF-706
ANL–					
89/35	15:32878	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010262	MF-201
90/7	15:33137	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010303	PC-511
ANL-HEP-CP–					
90-33	15:32966	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011107	MF-414
90-34	15:32967	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011112	MF-414
ANL-Trans–					
89-52	15:33607	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011335	MF-420
ANL/APS-TM–					
5	15:32919	NTIS, PC A12/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010201	MF-410
ANL/EAIS/TM–					
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ANL/ESD–					
3	15:32499	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010305	MF-364
ANL/ESH/TS–					
90/101	15:33114	NTIS, PC A15/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010909	
90/103	15:33115	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011137	
ANU-PRL-PP–					
89/6	15:33802	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625560	
89/8	15:33730	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625514	
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BINE–					
0007	15:32195	*See* CNIC–00170			
BISI–					
26649	15:32500	the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
26680	15:32501	the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
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43273	15:32930	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010645	MF-414
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44536	15:33212	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010650	MF-408
44583	15:32920	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011121	MF-405
44606	15:32907	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011122	MF-414
BNL-NUREG–					
44506	15:32200	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010643	
BONN-IR–					
89-43	15:33426	NTIS (US Sales Only), PC A08/MF A01		DE90792258	
89-46	15:32968	NTIS (US Sales Only), PC A04/MF A01		DE90792235	
90-05	15:33427	NTIS (US Sales Only), PC A05/MF A01		DE90792220	
BONN-ME–					
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BRIUOP–					
0005	15:32193	*See* CNIC–00112			
BSPHN–					
0001	15:33599	*See* CNIC–00223			
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Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
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CESAR–					
90/12	15:32853	*See* ORNL/TM–11510			
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9002	15:32096	Institut for Kemiteknik, Danmarks Tekniske Hoejskole, Bygning 229, 2800 Lyngby, Denmark			
CMI-R–					
89/30701	15:32451	NTIS (US Sales Only), PC A03/MF A01		DE90791370	
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Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
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00237	15:32779	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627756	
00257	15:32191	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627893	
00269	15:33432	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627496	
CONF-8306308–		(American Geophysical Union symposium: the earth's electrical environment; Baltimore, MD (USA); Jun 1983)			
	15:33052	NTIS, PC A12/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010444	MF-403
CONF-870811–		(Energy conservation program evaluation: practical methods and useful results; Chicago, IL (USA); 19-21 Aug 1987)			
Vol.2	15:32479	NTIS, PC A21/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010891	MF-400
CONF-870963–		(Electric thermal storage conference and exposition; Binghamton, NY (USA); 22-24 Sep 1987)			
	15:32490	New York State Energy Research and Development Authority, 2 Rockefeller Plaza, Albany, NY 12223 (USA)			
CONF-8805367–		(Workshop on the calibration of stellar ages; Middletown, CT (USA); 13-14 May 1988)			
	15:33299	*See* N–90-15869			
CONF-8805371–		(Sorrento Congress of the Insurance Study Committee; Sorrento (Italy); 30 May - 3 jun 1988)			
	15:32367	*See* INIS-XN–231			
	15:32368	*See* INIS-XN–232			
CONF-880613–		(14. international symposium on effects of radiation on materials; Andover, MA (USA); 27-29 Jun 1988)			
	15:32533	*See* CEA-DAS–540			
CONF-880679–		(81. annual meeting of Air Pollution Control Association; Dallas, TX (USA); 19-24 Jun 1988)			
	15:32151	Air Pollution Control Assoc., Publishing Department, P.O. Box 2861, Pittsburgh, PA 15230 (USA)			
CONF-8807162–		(Relativistic, quantum electrodynamic, and weak interaction effects in atoms; Santa Barbara, CA (USA); Jul 1988)			
	15:33346				
	15:33350				
CONF-8808146–		(10. international free-electron laser conference; Jerusalem (Israel); 29 Aug - 2 sep 1988)			
	15:32921	*See* CEA-CONF–9798			
CONF-880983–		(8. international symposium on high energy spin physics; Minneapolis, MN (USA); 12-17 Sep 1988)			
	15:33399	*See* CEA-CONF–9812			
CONF-8810155–		(16. water reactor safety information meeting; Gaithersburg, MD (USA); 24-27 Oct 1988)			
50	15:32200	*See* BNL-NUREG–44506			
CONF-8810399–		(4. international laser science conference; Atlanta, GA (USA); 2-6 Oct 1988)			
	15:32748				
CONF-881054–		(4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988)			
49	15:33566	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010721	MF-413
CONF-8811279–		(Multicomponent ultrafine microstructures; Boston, MA (USA); 30 Nov - 1 dec 1988)			
	15:32617	Materials Research Society, 9800 McKnight Rd., Suite 327, Pittsburgh, PA 15237 (USA)			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-8901120–		(27. international winter meeting on nuclear physics; Bormio (Italy); 23-27 Jan 1989)			
	15:33577	*See* LPN–89-01			
CONF-8901190–		(Workshop on dark matter and the structure of the universe; Takehara (Japan); 29 Jan - 1 feb 1989)			
	15:33315	*See* RRK–89-28			
CONF-890130–		(13. annual conference on composites and advanced ceramics; Cocoa Beach, FL (USA); 15-18 Jan 1989)			
	15:32521				
	15:32522				
CONF-890195–		(Workshop on the analysis of returned comet nucleus samples; Milpitas, CA (USA); 16-18 Jan 1989)			
	15:33303	*See* N–90-16607			
CONF-8902107–		(School on nuclear matter and heavy ion collisions; Les Houches (France); 7-16 Feb 1989)			
	15:33431	*See* CEA-CONF–9854			
CONF-8902178–		(Treatment and destruction of hazardous chemical wastes; Erice (Italy); 8 Feb 1989)			
1	15:33106	*See* UCRL–102785			
CONF-8902179–		(EPRI remedial measures workshop; Clearwater Beach, FL (USA); 8-10 Feb 1989)			
Summ.	15:32336	*See* EPRI-NP–6719-M			
CONF-8903207–		(15. Czechoslovak seminar on plasma physics and technology; Liblice (Czechoslovakia); 13-17 Mar 1989)			
	15:33722	*See* IPPCZ–293/II			
CONF-8903213–		(Meeting of University Group of Thermics; Paris (France); 22 Mar 1989)			
	15:32841	*See* CEA-CONF–9979			
CONF-890403–		(7. international workshop on stellarators; Oak Ridge, TN (USA); 10-14 Apr 1989)			
	15:33802	*See* ANU-PRL-PP–89/6			
CONF-8904159–		(International Atomic Energy Agency fusion reactor safety meeting; Jackson, WY (USA); 4-7 Apr 1989)			
5	15:33813	*See* EGG-M–89060			
CONF-8904193–		(22. annual oil shale symposium; Golden, CO (USA); 19-20 Apr 1989)			
4	15:32190	*See* EGG-M–88503			
CONF-8904349–		(16. international conference on metallurgical coatings; San Diego, U (USA); 17-21 Apr 1989)			
	15:32532	*See* CEA-CONF–9871			
CONF-8904353–		(NGO strategy seminar on air pollution; Ede (Netherlands); 3-4 Apr 1989)			
	15:32105	*See* SNM-BAC–89/1			
CONF-890488–		(4. international symposium on ceramics in nuclear waste management; Indianapolis, IN (USA); 23-27 Apr 1989)			
14	15:32213	*See* DP-MS–89-78			
CONF-8905102–		(39. electronic components conference; Houston, TX (USA); 22-24 May 1989)			
2	15:32714	*See* UCRL–100808			
CONF-8905106–		(Workshop on greenhouse-gas induced climate change: a critical appraisal of simultations and observations; Amherst, MA (USA); 8-12 May 1989)			
2	15:33107	*See* UCRL-JC–103431			
CONF-890515–		(2. international Rolduc symposium on coal science; Rolduc (Netherlands); 22-24 May 1989)			
	15:32089				
CONF-8905161–		(International conference on surface and thin film studies using glancing-incidence x-ray and neutron scattering; Marseille (France); 31 May - 2 jun 1989)			
	15:33614	*See* CEA-CONF–9903			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-8905208–		(3. international conference on elastic and diffractive scattering; Evanston, IL (USA); 2-6 May 1989)			
4	15:33407	*See* LBL–28736			
CONF-8905315–		(2. Yayoi workshop on fusion reactor engineering; Tokyo (Japan); 8-9 May 1989)			
	15:33825	*See* UTNL-R–239			
CONF-890543–		(Spring meeting of the American Physical Society; Baltimore, MD (USA); 1-4 May 1989)			
	15:33574	*See* ISN–89-37			
CONF-890546–		(ICHMT international seminar on fission product transport processes in reactor accidents; Dubrovnik (Yugoslavia); 22-26 May 1989)			
9	15:32345	*See* EGG-M–89276			
CONF-890560–		(12. international conference on cyclotrons and their applications; Berlin (Germany, F.R.); 8-12 May 1989)			
	15:32908	*See* ISN–89-46			
CONF-890582–		(EPRI symposium on biological processing of coal and coal-derived substances; Palo Alto, CA (USA); 16-17 May 1989)			
4	15:32067	*See* EGG-M–89221			
CONF-8906168–		(International conference on selected topics in nuclear structure; Dubna (USSR); 20-24 Jun 1989)			
	15:33575	*See* ISN–89-47			
CONF-8906270–		(Summer school of computational atomic and nuclear physics; Sewanee, TN (USA); 26 Jun - 7 jul 1989)			
5	15:33328	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011078	MF-411
CONF-8906320–		(Strategic defense initiative technical achievements symposium; Washington, DC (USA); 29-30 Jun 1989)			
1	15:33044	*See* UCRL–101292			
CONF-8906325–		(50. Anniversary of Fission Discovery; Palaiseau (France); 21 Jun 1989)			
	15:33565	*See* CEA-CONF–9981			
CONF-890686–		(International conference on new aspects of nuclear spectroscopy; Crete (Greece); 26 Jun - 1 jul 1989)			
	15:33578	*See* LUND-MPh–89-06			
CONF-890703–		(International conference on ion sources; Berkeley, CA (USA); 10-14 Jul 1989)			
	15:32928				
	15:32952				
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	15:33792				
	15:33833				
CONF-8907134–		(17. SLAC summer institute on particle physics: physics at the 100 GeV mass scale; Stanford, CA (USA); 10-21 Jul 1989)			
	15:33398	*See* SLAC–361			
CONF-8907191–		(Workshop on global climate change and its effects on California; Davis, CA (USA); 10-12 Jul 1989)			
1	15:33103	*See* UCRL–101735			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-890770–		(16. annual review of progress in quantitative nondestructive evaluation; Brunswick, ME (USA); 23-28 Jul 1989)			
9	15:32848	*See* EGG-M–89148			
10	15:32066	*See* EGG-M–89151			
CONF-890612–		(American Physical Society topical conference on shock compression of condensed matter; Albuquerque, NM (USA); 14-17 Aug 1989)			
66	15:32612	*See* EGG-M–89144			
67	15:32544	*See* EGG-M–89160			
CONF-890612B–		(Western Regional Strain Gage Committee meeting; Idaho Falls, ID (USA); 22 Aug 1989)			
2	15:32991	*See* EGG-M–89360			
CONF-8908142–		(14. international symposium on lepton and photon interactions at high energies; Stanford, CA (USA); 7-12 Aug 1989)			
6	15:33406	*See* LBL–28672			
CONF-890819–		(ASME/AIChE national heat transfer conference; Philadelphia, PA (USA); 6-9 Aug 1989)			
27	15:32319	*See* EGG-M–88444			
CONF-8906191–		(1. ISSP international symposium on the physics and chemistry of organic superconductors; Tokyo (Japan); 27-30 Aug 1989)			
3	15:32803	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010502	MF-401
CONF-8906227–		(DOE low-level waste management conference; Denver, CO (USA); 21 Aug 1989)			
1	15:32215	*See* EGG-M–89251			
CONF-8906228–		(Symposium on the plan for establishment of Health Physics Research Center; Kumatori (Japan); 8 Aug 1989)			
	15:32254	*See* KURRI-TR–325			
CONF-890836–		(33. SPIE annual international technical symposium on optical and optoelectronic applied science and engineering; San Diego, CA (USA); 6-11 Aug 1989)			
24	15:32979	*See* UCRL–101659			
CONF-890855–		(10. international conference on Structural Mechanics in Reactor Technology (SMIRT); Anaheim, CA (USA); 14-18 Aug 1989)			
60	15:32362	*See* EGG-M–89329			
CONF-8909248–		(6. international RETRAN meeting; Arlington, VA (USA); 18-20 Sep 1989)			
2	15:32363	*See* EGG-M–89393			
CONF-890928–		(Nuclear waste isolation in the unsaturated zone: FOCUS '89; Las Vegas, NV (USA); 18-21 Sep 1989)			
23	15:32239	*See* UCRL–100211			
CONF-8909326–		(Workshop on the new phase for JET: the pumped divertor proposal; Culham (UK); 25-26 Sep 1989)			
	15:33764	*See* JET-R–(89)16			
CONF-8909327–		(13. international school of theoretical physics: Standard model and beyond; Szczyrk (Poland); 19-26 Sep 1989)			
	15:33508	*See* NORDITA–89/51-P(prepr.)			
CONF-8909331–		(COMPUMAG Tokyo conference; Tokyo (Japan); 3-7 Sep 1989)			
1	15:33731	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011097	MF-420
CONF-891007–		(13. IEEE symposium on fusion engineering; Knoxville, TN (USA); 2-6 Oct 1989)			
119	15:33822	*See* SAND–89-2405			
120	15:33804	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011154	MF-424
CONF-8910241–		(35. conference on bioassay, analytical and environmental chemistry; Charleston, SC (USA); 30 Oct - 2 nov 1989)			
6	15:32785	*See* EGG-M–89267			
CONF-8910269–		(8. annual meeting of the American Association for Aerosol Research; Reno, NV (USA); 10-13 Oct 1989)			
2	15:33108	*See* UCRL-JC–103591			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-891027–		(International symposium on research reactor safety, operations and modifications; Chalk River (Canada); 23-27 Oct 1989)			
7	15:32351	*See* EGG-M–89075			
8	15:32350	*See* EGG-M–89074			
CONF-891031–		(Annual meeting of the Geothermal Resources Council: the geysers - three decades of achievement: a window on the future; Santa Rosa, CA (USA); 1-4 Oct 1989)			
11	15:32297	*See* UCRL–100841			
CONF-8910357–		(Impedance and bunch instability workshop; Argonne, IL (USA); 31 Oct - 1 nov 1989)			
	15:32919	*See* ANL/APS-TM–5			
CONF-8910367–		(3. international conference of anticarcinogens and radiation protection; Dubrovnik (Yugoslavia); 15-21 Oct 1989)			
2	15:33221	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010542	MF-408
CONF-8910403–		(11. autumn school in physics on hadrons: their structure and interactions; Lisbon (Portugal); 9-14 Oct 1989)			
	15:33450	*See* NBI-HE–90-01			
CONF-891082–		(International conference on new trends in liquid scintillation counting and organic scintillators; Gatlinburg, TN (USA); 2-5 Oct 1989)			
3	15:32974	*See* EGG-M–89295			
CONF-891098–		(The scientific challenges of NEPA: future directions based on 20 years of experience; Knoxville, TN (USA); 24-27 Oct 1989)			
3	15:32277	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90003546	MF-630
CONF-891103–		(Winter meeting of the American Nuclear Society; San Francisco, CA (USA); 26-30 Nov 1989)			
70	15:32360	*See* EGG-M–89114			
71	15:32358	*See* EGG-M–89106			
72	15:32359	*See* EGG-M–89113			
73	15:32361	*See* EGG-M–89219			
CONF-8911130–		(11. US/Japan workshop on field-reversed configurations and compact toroids; Los Alamos, NM (USA); 7-9 Nov 1989)			
	15:33820	*See* LA–11808-C			
CONF-8911164–		(1989 superstrings workshop; Tuscaloosa, AL (USA); 8-11 Nov 1989)			
	15:33509	*See* NORDITA–89/59-P(prepr.)			
CONF-891119–		(Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989)			
132	15:32802	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011178	MF-404
CONF-8911190–		(Meeting of physicists within the SATURNE III project; Saclay (France); 23-24 Nov 1989)			
	15:33552	*See* GSI–90-14(prepr.)			
CONF-891204–		(4. international conference on fusion reactor materials; Kyoto (Japan); 4-8 Dec 1989)			
33	15:33805	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011170	MF-424
CONF-891288–		(8. European tokamak programme workshop; Gut Ising (Germany, F.R.); 13-15 Dec 1989)			
	15:33779	*See* Juel–2342			
CONF-900102–		(13. energy-sources technology conference and exhibition; New Orleans, LA (USA); 14-18 Jan 1990)			
5	15:32502	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009723	MF-317
CONF-900135–		(15. general meeting of the Division of Particles and Fields of the American Physical Society; Houston, TX (USA); 3-6 Jan 1990)			
5	15:33410	*See* SLAC-PUB–5236			
CONF-900140–		(SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition; Los Angeles, CA (USA); 15-19 Jan 1990)			
24	15:33214	*See* LA-UR–90-1438			
25	15:32884	*See* UCRL–102201			
26	15:32885	*See* UCRL–102667			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-900147–		(13. symposium on nuclear physics; Oaxtepec (Mexico); 3-6 Jan 1990)			
	15:33444	*See* KFK–4706			
CONF-900179–		(Los Alamos National Laboratory (LANL) workshop on n-p Bremsstrahlung; Los Alamos, NM (USA); 25-26 Jan 1990)			
3	15:33451	*See* UCRL-JC–103865			
CONF-900190–		(Synchrotron x-ray sources and new opportunities in the agricultural and related sciences workshop; Argonne, IL (USA); 8-10 Jan 1990)			
1	15:33327	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011177	MF-404; MF-411
CONF-9002120–		(National symposium on methanol vehicles; Tokyo (Japan); 6-8 Feb 1990)			
1	15:32525	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009719	MF-330
CONF-9002121–		(4. U.S. Department of Energy Office of Environmental Restoration and Waste Management waste reduction workshop; Tampa, FL (USA); 6-7 Feb 1990)			
	15:32204	*See* DOE/HWP–99			
CONF-900302–		(SPIE's symposium on advances in semiconductors and superconductors: physics toward device applications; San Diego, CA (USA); 17-21 Mar 1990)			
1	15:32698	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011321	MF-404
CONF-9003128–		(6. annual review of progress in applied computational electromagnetics; Monterey, CA (USA); 20-22 Mar 1990)			
3	15:32887	*See* UCRL-JC–103302			
CONF-9003150–		(5. international conference on instrumentation for colliding beam physics; Novosibirsk (USSR); 15-21 Mar 1990)			
3	15:32978	*See* SLAC-PUB–5214			
CONF-9003153–		(Workshop on the alternative to open burning/open detonation of propellants and explosives; Panama City, FL (USA); 27-28 Mar 1990)			
1	15:32806	*See* LA-UR–90-1338			
CONF-9003154–		(Workshop on atomic physics at the Advanced Photon Source; Argonne, IL (USA); 23-30 Mar 1990)			
2	15:32932	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011099	MF-411
CONF-9003155–		(2. international conference on diffusion bonding-applications; Cranfield (UK); 28-29 Mar 1990)			
1	15:32558	*See* UCRL–101690			
CONF-9003158–		(ACSM-ASPRS spring convention; Denver, CO (USA); 19-23 Mar 1990)			
1	15:32910	*See* SLAC-PUB–5226			
CONF-9003159–		(Workshop on radiation hardness of plastic scintillator; Tallahassee, FL (USA); 19-21 Mar 1990)			
1	15:32967	*See* ANL-HEP-CP–90-34			
CONF-9003161–		(25. Rencontres de Moriond on QCD and hadronic interactions conference; Les Arcs (France); Mar 1990)			
1	15:33433	*See* DOE/ER/13065–568			
CONF-900331–		(Workshop on heavy ion physics at the alternating gradient synchrotron; Upton, NY (USA); 3-7 Mar 1990)			
7	15:33562	*See* BNL–44522			
CONF-900348–		(2. international industrial symposium on the super collider; Miami, FL (USA); 14-16 Mar 1990)			
3	15:32930	*See* BNL–43273			
5	15:32938	*See* SLAC-PUB–5211			
6	15:32966	*See* ANL-HEP-CP–90-33			
7	15:32931	*See* BNL–43413			
CONF-900402–		(199. national meeting of the American Chemical Society; Boston, MA (USA); 22-27 Apr 1990)			
7	15:32780	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011163	MF-401

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-9004105–		(Superconductivity applications for infrared and microwave devices; Orlando, FL (USA); 16-20 Apr 1990)			
1	15:32989	*See* LBL–28885			
CONF-9004110–		(4. national conference on microcomputer applications in energy; Tucson, AZ (USA); 25-27 Apr 1990)			
2	15:32097	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011091	MF-101
CONF-9004131–		(The national energy strategy–the role of geothermal technology development; San Francisco, CA (USA); 18-20 Apr 1990)			
1	15:32299	*See* SAND–90-1075C			
CONF-9004133–		(American power conference; Chicago, IL (USA); 23-25 Apr 1990)			
3	15:32318	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011145	MF-101
CONF-9004147–		(1990 JANNAF propulsion systems hazards meeting; Laurel, MD (USA); 3-5 Apr 1990)			
5	15:33031	*See* UCRL–102578			
CONF-9004159–		(5. distributed memory computing conference; Charleston, SC (USA); 9-12 Apr 1990)			
7	15:33842	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011076	MF-405
CONF-9004171–		(International conference on mechanics of jointed and faulted rocks; Vienna (Austria); 18-20 Apr 1990)			
3	15:33039	*See* UCRL-JC–103498			
CONF-900418–		(International conference on the physics of reactors: operation, design and computation; Marseilles (France); 23-26 Apr 1990)			
15	15:32326	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011153	MF-534
CONF-9004181–		(DOE Remedial Action Program conference; Albuquerque, NM (USA); 16-19 Apr 1990)			
2	15:32253	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011182	MF-511
CONF-9004182–		(17. environmental symposium: environmental compliance and enforcement at DOD installations in the 1990's; Atlanta, GA (USA); 17-20 Apr 1990)			
1	15:32442	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010099	
2	15:32505	*See* EGG-M–90162			
CONF-9004184–		(25. Yamada conference on magnetic phase transitions; Osaka (Japan); 13-16 Apr 1990)			
2	15:32613	*See* LBL–28863			
CONF-9004187–		(ACM SIGCHI '90 workshop on multimedia and multimodal interface design; Seattle, WA (USA); 1-2 Apr 1990)			
1	15:33388	*See* UCRL-JC–103579			
CONF-9004188–		(3. national symposium on sensor fusion; Orlando, FL (USA); 16-20 Apr 1990)			
1	15:33034	*See* UCRL-JC–103626			
CONF-9004190–		(Computing in high energy physics; Santa Fe, NM (USA); 9-13 Apr 1990)			
1	15:32906	*See* BNL–44466			
2	15:32939	*See* SLAC-PUB–5243			
CONF-9004191–		(7. international conference on systems engineering; 11. structured development forum; Las Vegas, NV (USA); San Diego, CA (USA); 18-20 Jul 1990; 30 apr - 3 may 1990)			
1	15:33838	*See* EGG–10617-1081			
CONF-9004192–		(Society for Occupational and Environmental Health annual conference; Bethesda, MD (USA); 23-25 Apr 1990)			
1	15:33234	*See* LA-UR–90-1329			
CONF-9004193–		(Symposium on ferroelectric thin films; San Francisco, CA (USA); 18-20 Apr 1990)			
1	15:32712	*See* SAND–90-1077C			
CONF-9004194–		(ASME/IEEE joint railroad conference; Chicago, IL (USA); 16-19 Apr 1990)			
1	15:32491	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010046	MF-330
CONF-9004197–		(2. symposium on use of plants for toxicity assessment; San Francisco, CA (USA); 23-24 Apr 1990)			
1	15:33139	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011063	MF-702; MF-722

CONF-9004201–

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-9004201–		(ASM international conference: tribology of composites; Oak Ridge, TN (USA); 30 Apr 1990)			
1	15:32609	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011313	MF-373
CONF-900432–		(Science and technology of thin-film superconductors conference; Golden, CO (USA); 30 Apr - 4 may 1990)			
1	15:32604	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011161	MF-404
CONF-900435–		(International symposium on measurement of toxic and related air pollutants; Raleigh, NC (USA); 30 Apr - 3 may 1990)			
1	15:33061	*See* LA-UR–90-1332			
CONF-900466–		(Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990)			
32	15:32716	*See* UCRL-JC–103630			
34	15:32536	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010496	MF-404
35	15:32699	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010439	MF-404
36	15:32615	*See* SAND–90-1111C			
37	15:32537	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011064	MF-404
38	15:33615	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011111	MF-404
40	15:32808	*See* UCRL-JC–103872			
41	15:32977	*See* LBL–28836			
42	15:32715	*See* UCRL–102758			
44	15:32616	*See* SAND–90-1229C			
45	15:32605	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011333	MF-336
CONF-900491–		(5. international conference on accelerator mass spectrometry; Paris (France); 23-27 Apr 1990)			
2	15:32941	*See* UCRL–102982			
3	15:32943	*See* UCRL–102986			
4	15:32942	*See* UCRL–102983			
5	15:33196	*See* UCRL–102985			
6	15:32944	*See* UCRL–102987			
CONF-900494–		(1990 SCS Eastern multiconference; Nashville, TN (USA); 23-29 Apr 1990)			
5	15:32242	*See* WSRC-RP–89-1348			
CONF-900505–		(9. plasma interaction conference; Bournemouth (UK); 20-25 May 1990)			
1	15:32710	*See* SAND–89-3001C			
2	15:33806	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011390	MF-420
CONF-900512–		(12. symposium on biotechnology for fuels and chemicals; Gatlinburg, TN (USA); 7-11 May 1990)			
1	15:33192	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010706	MF-401
2	15:33215	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010701	MF-401
CONF-9005122–		(1990 conference on the application of 3-D hydrocodes to armor/anti-armor problems; Aberdeen Proving Ground, MD (USA); 7-11 May 1990)			
2	15:33033	*See* UCRL-JC–103512			
3	15:32873	*See* SAND–90-0506C			
CONF-9005123–		(9. annual international symposium on the incineration of radioactive, hazardous, mixed and medical wastes: incineration conference '90; San Diego, CA (USA); 14-18 May 1990)			
2	15:32199	*See* BNL–43691			
3	15:32216	*See* EGG-M–89464			
CONF-9005161–		(Gatlinburg actinide separations conference; Gatlinburg, TN (USA); 15 May 1990)			
2	15:32234	*See* RFP–4410			
CONF-9005168–		(4. annual conference on liquid atomization and spray systems; Hartford, CT (USA); 20-23 May 1990)			
1	15:32862	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010580	MF-406
CONF-9005169–		(Recycling-plas V conference; Washington, DC (USA); 23-24 May 1990)			
1	15:32514	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010716	MF-402
CONF-9005170–		(1. internatonal symposium on metal ions in biology and medicine; Champagne (France); 16-19 May 1990)			
1	15:33212	*See* BNL–44536			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-9005171–		(3. symposium on social science in resource management; College Station, TX (USA); 16-19 May 1990)			
1	15:33053	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010714	MF-400
CONF-9005172–		(21. annual conference on modeling and simulation; Pittsburgh, PA (USA); 3-4 May 1990)			
1	15:32429	NTIS, PC A02/MF A01 - OSTI		DE90010710	MF-222
CONF-9005173–		(23. oil shale symposium; Golden, CO (USA); May 1990)			
1	15:32184	*See* SAND–90-0464C			
CONF-9005174–		(International conference on dynamics of flexible structures in space; Cranfield (UK); 15-18 May 1990)			
1	15:32497	*See* UCRL–102927			
CONF-9005175–		(Automatic RF Technology Group (ARFTG) conference; Dallas, TX (USA); 10-11 May 1990)			
1	15:32883	*See* SAND–90-1209C			
CONF-9005178–		(2. annual international seminar on radioactive waste products; Julich (Germany, F.R.); 28 May - 1 jun 1990)			
1	15:32217	*See* EGG-M–90189			
CONF-9005179–		(Loss of Fluid Test final meeting (achievements of the OECD LOFT Project); Madrid (Spain); 8-11 May 1990)			
1	15:32346	*See* EGG-M–90151			
CONF-9005183–		(8. symposium on energy engineering sciences; Argonne, IL (USA); 9-11 May 1990)			
1	15:33632	*See* SAND–90-1265C			
CONF-900519–		(Nonmetallic materials and composites at low temperatures; Heidelberg (Germany, F.R.); 17-18 May 1990)			
1	15:33807	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011318	MF-422
CONF-900534–		(18. NATO/CCMS international technical meeting on air pollution modelling and its applications; Vancouver (Canada); 13-17 May 1990)			
1	15:33109	*See* UCRL-JC–103969			
CONF-900546–		(4. conference on fossil energy materials; Oak Ridge, TN (USA); 15-17 May 1990)			
1	15:32044	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011068	MF-114
2	15:32112	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011092	MF-114
CONF-900563–		(7. symposium on radiation measurements and applications; Ann Arbor, MI (USA); 21-24 May 1990)			
1	15:32197	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010440	MF-606
4	15:32258	*See* LA-UR–90-1372			
5	15:33009	*See* SAND–90-0164C			
6	15:32973	*See* EGG–10617-2066			
CONF-900582–		(NATO Advanced Study Institute on interaction of charged particles with solids and surfaces; Alicante (Spain); 6-18 May 1990)			
1	15:33616	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011381	MF-411
CONF-900599–		(36. Instrument Society of America international instrumentation symposium; Denver, CO (USA); 6-10 May 1990)			
6	15:32306	*See* SERI/TP–257-3695			
CONF-900608–		(American Nuclear Society annual meeting; Nashville, TN (USA); 10-14 Jun 1990)			
17	15:32857	*See* SAND–90-0348C			
18	15:32858	*See* SAND–90-0352C			
CONF-9006105–		(28. symposium on engineering aspects of magnetohydrodynamics; Chicago, IL (USA); 26-28 Jun 1990)			
1	15:32473	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011160	
CONF-9006114–		(4. ACM international conference on supercomputing; Amsterdam (Netherlands); 11-15 Jun 1990)			
1-Rev.1	15:33854	*See* UCRL–102737-Rev.1			
CONF-9006139–		(ACS symposium on emerging technologies for hazardous waste treatment; Atlantic City, NJ (USA); 4-7 Jun 1990)			
1	15:32203	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010703	MF-400; MF-402

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-9006146–		(34. international power sources symposium; Cherry Hill, NJ (USA); 25-28 Jun 1990)			
4	15:32440	*See* SAND–89-2229C			
5	15:32441	*See* SAND–89-2342C			
6	15:32523	*See* EGG-M–90200			
CONF-9006153–		(21. AIAA fluid dynamics, plasmadynamics and laser conference in conjuction with the AIAA 25th thermophysics and heat transfer conference and the 16th aerodynamic ground testing conference; Seattle, WA (USA); 18-20 Jun 1990)			
1	15:32709	*See* SAND–89-2389C			
CONF-9006169–		(7. international conference on logic programming; Jerusalem (Israel); 18-21 Jun 1990)			
2	15:33843	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011117	MF-405
CONF-900617–		(Pressure vessels and piping conference: be in tune for the 90's; Nashville, TN (USA); 17-21 Jun 1990)			
12	15:32364	*See* EGG-M–89412			
14	15:32842	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011171	
CONF-9006171–		(Solid state sensor and actuator workshop; Hilton Head Island, SC (USA); 4-7 Jun 1990)			
1	15:33008	*See* SAND–89-0126C			
CONF-9006173–		(US-USSR exchange meeting on reactor safety; Moscow (USSR); 25-29 Jun 1990)			
1	15:32356	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010717	
CONF-9006174–		(5. international conference on metalorganic vapor phase epitaxy; Aachen (Germany, F.R.); 18-21 Jun 1990)			
1	15:32711	*See* SAND–90-0088C			
CONF-9006175–		(Meeting of the American Society for Engineering Education; Toronto (Canada); Jun 1990)			
1	15:32462	*See* BNL–44454			
CONF-9006176–		(19. power modulator symposium; San Diego, CA (USA); Jun 1990)			
1	15:32940	*See* UCRL–102623			
CONF-9006177–		(22. International Institution for Production Engineering Research (CIRP) international seminar on manufacturing; Enschede (Netherlands); 11-12 Jun 1990)			
1	15:33848	*See* KCP–613-4215			
CONF-9006178–		(1990 Society of Women Engineers national convention and student conference; New York, NY (USA); 24 Jun - 1 jul 1990)			
1	15:32262	*See* WHC-SA–0881			
CONF-900623–		(15. symposium on effects of radiation on materials; Nashville, TN (USA); 17-21 Jun 1990)			
7	15:32538	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011075	MF-404
8	15:32539	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011114	MF-404
9	15:32540	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011115	MF-404
10	15:32541	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011106	MF-404
CONF-900634–		(7. world ceramics congress: ceramics today–tomorrow's ceramics; Montecatini Terme (Italy); 24-30 Jun 1990)			
1	15:32606	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011090	MF-404
CONF-900654–		(32. electronic materials conference; Santa Barbara, CA (USA); 27-29 Jun 1990)			
1	15:32713	*See* SAND–90-1177C			
CONF-900676–		(83. annual meeting and exhibition of the Air and Waste Management Association; Pittsburgh, PA (USA); 24-29 Jun 1990)			
4	15:32202	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011116	MF-511
5	15:32513	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011118	MF-249
6	15:33048	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011152	MF-902
CONF-900703–		(11. international symposium on chemical reaction engineering (ISCRE '11); Toronto (Canada); 8-11 Jul 1990)			
1	15:32290	*See* SAND–89-3086C			
CONF-900704–		(23. Combustion Institute symposium on combustion; Orleans (France); 22-27 Jul 1990)			
1	15:32167	*See* UCRL–102497-1			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
2	15:32519	*See* UCRL–102495			
3	15:32520	*See* UCRL–102496			
4	15:32836	*See* UCRL–102584			
5	15:32789	*See* UCRL–102494			
6	15:32860	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007571	MF-406
7	15:32861	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006312	MF-406
8	15:32837	*See* UCRL–102778			
9	15:32835	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009022	MF-401
10	15:32781	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010500	MF-401
CONF-900705–		(8. world hydrogen energy conference; Honolulu, HI (USA); 22-27 Jul 1990)			
2	15:32265	*See* LA-UR–90-753			
3	15:32266	*See* BNL–44410			
CONF-900709–		(Symposium on high temperature superconductors of the 7th world ceramic congress; Trieste (Italy); 2-5 Jul 1990)			
1	15:32607	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011109	MF-404
CONF-900712–		(21. international conference of the Fraunhofer-Institut fuer Chemische Technologie: technology of polymer compounds and energetic materials; Karlsruhe (Germany, F.R.); 3-6 Jul 1990)			
1	15:33032	*See* UCRL-JC–103244			
2	15:33029	*See* UCRL–102393			
3	15:33030	*See* UCRL–102395			
CONF-900723–		(27. IEEE annual international nuclear and space radiation effects conference; Reno, NV (USA); 16-20 Jul 1990)			
1	15:33043	*See* SAND–90-0226C			
2	15:33042	*See* SAND–90-0161C			
3	15:32986	*See* SAND–90-0367C			
4	15:32557	*See* SAND–90-0341C			
5	15:32881	*See* SAND–90-0368C			
6	15:32987	*See* SAND–90-0410C			
7	15:32985	*See* SAND–90-0344C			
8	15:32937	*See* SAND–90-0394C			
9	15:33853	*See* SAND–90-0480C			
10	15:32882	*See* SAND–90-0436C			
11	15:32988	*See* SAND–90-0501C			
CONF-900724–		(5. international conference on indoor air quality and climate; Toronto (Canada); 29 Jul - 3 aug 1990)			
1	15:33257	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009239	MF-407
2	15:33049	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009237	MF-407
3	15:33118	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009238	MF-407
4	15:32480	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009236	MF-407
5	15:32481	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009421	MF-402
6	15:33050	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009422	
7	15:32782	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009423	
CONF-900729–		(Japan-USA symposium on flexible automation; Kyoto (Japan); 9-11 Jul 1990)			
1	15:32843	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90003063	MF-406
2	15:32844	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005280	MF-406
CONF-900737–		(Ion-Ex '90; Cartrefle (UK); 9-11 Jul 1990)			
1	15:32700	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90003717	MF-401
CONF-900742–		(International compressor engineering conference, USNC/IIR-Purdue refrigeration conference and ASHRAE-Purdue CFC conference; West Lafayette, IN (USA); 17-20 Jul 1990)			
1	15:32503	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010146	MF-350
2	15:32701	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010493	MF-350
CONF-900756–		(SPIE's international symposium on optical and optoelectronic applied science and engineering and exhibit; San Diego, CA (USA); 8-13 Jul 1990)			
1	15:32992	*See* EGG-M–90027			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-900758–		(2. annual envirACS exposition and 6th annual waste testing and quality assurance symposium; Washington, DC (USA); 17-19 Jul 1990)			
1	15:33119	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010438	MF-406
CONF-900764–		(Fatigue '90 international conference; Honolulu, HI (USA); 15-20 Jul 1990)			
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2	15:33838	*See* EGG–10617-1081			
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3	15:32871	*See* SAND–90-0230C			
4	15:33026	*See* SAND–90-0125C			
5	15:33028	*See* SAND–90-0577C			
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89/410	15:33679	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627155	
89/411	15:33680	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627156	
89/412	15:33681	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627157	
89/415	15:33439	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627523	
89/417	15:33625	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627318	
89/418	15:32805	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627792	
89/421	15:33006	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90628281	
89/422	15:33682	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627158	
89/423	15:33491	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627212	
89/424	15:33492	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627213	
89/425	15:33683	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627181	
89/426	15:33653	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627492	
89/427	15:33654	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627493	
89/428	15:33684	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627159	
89/429	15:33493	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627214	
89/431	15:33494	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627215	
89/432	15:33685	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627160	
89/433	15:33568	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627592	
89/434	15:33686	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627161	
90/10	15:33690	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627162	
90/11	15:33497	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627216	
90/13	15:33691	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627163	
90/14	15:33692	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627164	
90/15	15:33292	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627485	
90/16	15:33693	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627165	
90/17	15:33694	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627197	
90/18	15:33293	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627482	
90/19	15:33695	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627198	
90/2	15:33626	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90627319	
90/20	15:33498	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627217	
90/21	15:33499	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627218	
90/22	15:33500	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90627219	
90/23	15:33696	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627182	
90/3	15:33687	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627166	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
90/31	15:33697	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627167	
90/33	15:33501	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627220	
90/34	15:33698	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627168	
90/35	15:33699	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627169	
90/39	15:33700	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627199	
90/4	15:33688	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627170	
90/40	15:33701	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627171	
90/41	15:33502	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627221	
90/5	15:33495	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627222	
90/7	15:33496	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627223	
90/9	15:33689	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627172	
IFP–					
37-479	15:32130	NTIS (US Sales Only), PC A09/MF A01		DE90790593	
IFSR–					
432	15:33737	*See* DOE/ET/53088–432			
IFT-P–					
03/89	15:33503	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627224	
17/89	15:33440	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627511	
19/89	15:33441	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627524	
26/89	15:33442	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627512	
27/89	15:33702	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627183	
28/89	15:33703	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627184	
29/89	15:33704	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627185	
30/89	15:33569	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627537	
32/89	15:33294	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627486	
IFUSP-P–					
774	15:33541	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625914	
779	15:33335	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625340	
792	15:33570	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90625825	
IKE–					
4-132	15:32366	NTIS (US Sales Only), PC A12/MF A01		DE90792247	
6-179	15:32331	NTIS (US Sales Only), PC A07/MF A01		DE90792249	
IKU-R–					
31.8842.00/01/89	15:32131	NTIS (US Sales Only), PC A03/MF A01		DE90791375	
34.2783.03/01/89	15:32124	NTIS (US Sales Only), PC A03/MF A01		DE90791377	
34.2802.02/01/89	15:32125	NTIS (US Sales Only), PC A03/MF A01		DE90791379	
INIS-XN–					
231	15:32367	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90628322	
232	15:32368	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90628323	
INIS-mf–					
12597	15:32256	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90628330	
INS–					
786	15:33336	NTIS (US Sales Only), PC A02/MF A01		DE90791310	
794	15:32923	NTIS (US Sales Only), PC A02/MF A01		DE90791076	
798	15:33705	NTIS (US Sales Only), PC A03/MF A01		DE90791126	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
799	15:33337	NTIS (US Sales Only), PC A03/MF A01		DE90791129	
800	15:33476	NTIS (US Sales Only), PC A03/MF A01		DE90791127	
801	15:33571	NTIS (US Sales Only), PC A03/MF A01		DE90791128	
802	15:33531	NTIS (US Sales Only), PC A03/MF A01		DE90791105	
805	15:33477	NTIS (US Sales Only), PC A03/MF A01		DE90791142	
IPEN-PUB–					
283	15:33600	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626625	
IPNO-DRE–					
89-36	15:32833	NTIS (US Sales Only), PC A03/MF A01		DE90793018	
89-40	15:32787	NTIS (US Sales Only), PC A03/MF A01		DE90792927	
IPNO-TH–					
88-45	15:33572	NTIS (US Sales Only), PC A03/MF A01		DE90792988	
88-55	15:33443	NTIS (US Sales Only), PC A04/MF A01		DE90792883	
88-68	15:33573	NTIS (US Sales Only), PC A03/MF A01		DE90792987	
88-69	15:33338	NTIS (US Sales Only), PC A03/MF A01		DE90792986	
IPP–					
6/287	15:33741	NTIS (US Sales Only), PC A03/MF A01		DE90792234	
III/152	15:33760	NTIS (US Sales Only), PC A03/MF A01		DE90792226	
III/153	15:33818	NTIS (US Sales Only), PC A03/MF A01		DE90792228	
III/155	15:33761	NTIS (US Sales Only), PC A05/MF A01		DE90792232	
III/156	15:33762	NTIS (US Sales Only), PC A04/MF A01		DE90792230	
IPPCZ–					
293/II	15:33722	NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS		DE90627357	
ISN–					
89-37	15:33574	NTIS (US Sales Only), PC A02/MF A01		DE90792924	
89-46	15:32908	NTIS (US Sales Only), PC A02/MF A01		DE90792922	
89-47	15:33575	NTIS (US Sales Only), PC A02/MF A01		DE90792923	
IWS–					
036-23	15:33240	*See* PB–90-180746/XAB			
JAERI-M–					
89-133	15:33763	NTIS (US Sales Only), PC A16/MF A01		DE90791312	
89-182	15:32933	NTIS (US Sales Only), PC A03/MF A01		DE90791077	
89-206	15:32546	NTIS (US Sales Only), PC A07/MF A01		DE90791084	
89-213	15:32369	NTIS (US Sales Only), PC A05/MF A01		DE90791106	
89-220	15:32370	NTIS (US Sales Only), PC A07/MF A01		DE90791144	
89-221	15:32327	NTIS (US Sales Only), PC A05/MF A01		DE90791119	
89-222	15:32323	NTIS (US Sales Only), PC A05/MF A01		DE90791083	
89-223	15:32344	NTIS (US Sales Only), PC A04/MF A01		DE90791130	
89-224	15:32371	NTIS (US Sales Only), PC A04/MF A01		DE90791131	
89-225	15:32372	NTIS (US Sales Only), PC A06/MF A01		DE90791132	
89-227	15:32373	NTIS (US Sales Only), PC A06/MF A01		DE90791138	
90-002	15:32320	NTIS (US Sales Only), PC A03/MF A01		DE90791145	
90-003	15:32324	NTIS (US Sales Only), PC A07/MF A01		DE90791170	
90-004	15:33846	NTIS (US Sales Only), PC A04/MF A01		DE90791146	
90-008	15:32352	NTIS (US Sales Only), PC A04/MF A01		DE90791148	
90-009	15:32703	NTIS (US Sales Only), PC A03/MF A01		DE90791149	
90-013	15:32547	NTIS (US Sales Only), PC A03/MF A01		DE90791151	
90-031	15:33847	NTIS (US Sales Only), PC A05/MF A01		DE90791168	
JET-R–					
(89)16	15:33764	NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS		DE90625445	
JPL-Publ–					
89-37	15:33310	*See* N–90-16675			
Juel–					
2339	15:33778	NTIS (US Sales Only), PC A06/MF A01		DE90792214	
2342	15:33779	NTIS (US Sales Only), PC A03/MF A01		DE90792211	
Juel-Spez–					
535	15:33402	NTIS (US Sales Only), PC A07/MF A01		DE90792294	
K/QT–					
222	15:33060	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010895	MF-506
K/TR–					
90/1	15:32704	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011044	MF-406
KCP–					
613-4215	15:33848	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010849	MF-705
KEK–					
89-9	15:32934	NTIS (US Sales Only), PC A02/MF A01		DE90791246	
89-11	15:32935	NTIS (US Sales Only), PC A03/MF A01		DE90791081	
KFK–					
4649	15:33232	NTIS (US Sales Only), PC A07/MF A01		DE90792515	

KFK–

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
4671	15:32975	NTIS (US Sales Only), PC A05/MF A01		DE90792215	
4680	15:32257	NTIS (US Sales Only), PC A03/MF A01		DE90792464	
4687	15:32865	NTIS (US Sales Only), PC A05/MF A01		DE90792466	
4691	15:33553	NTIS (US Sales Only), PC A06/MF A01		DE90792217	
4692	15:33782	NTIS (US Sales Only), PC A05/MF A01		DE90792222	
4694	15:32374	NTIS (US Sales Only), PC A03/MF A01		DE90792468	
4706	15:33444	NTIS (US Sales Only), PC A09/MF A01		DE90792534	
KFK-PEF–					
60	15:33233	NTIS (US Sales Only), PC A05/MF A01		DE90792554	
KFKI–					
1989-40/A	15:33576	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627590	
1989-41/D	15:33783	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627431	
1989-42/I	15:32353	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90628209	
1989-44/G	15:32375	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90628165	
1989-45/A	15:33504	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627226	
1989-46/G	15:32340	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90628169	
1989-47/A	15:33445	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627526	
1989-48/A	15:33446	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627527	
1989-49/A	15:33296	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627488	
1989-52/B	15:33706	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627203	
1989-53/A	15:33707	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627187	
1989-54/A	15:33341	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627305	
1989-55/B	15:33708	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627204	
KURRI-TR–					
321	15:32354	NTIS (US Sales Only), PC A04/MF A01		DE90791245	
325	15:32254	NTIS (US Sales Only), PC A03/MF A01		DE90791143	
LA–					
11743-MS	15:33040	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010263	PC-700
11762-MS	15:32548	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010816	MF-904; MF-905
11765-MS	15:32453	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010261	PC-900
11776-MS	15:33041	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010341	PC-700
11808-C	15:33820	NTIS, PC A11/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010253	PC-424
LA-UR–					
90-1329	15:33234	NTIS, PC A04/MF A01 - OSTI		DE90010598	MF-907
90-1332	15:33061	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009749	
90-1333	15:32852	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010599	MF-705
90-1338	15:32806	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010600	
90-1372	15:32258	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010609	MF-731
90-1438	15:33214	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010619	
90-753	15:32265	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008964	
90-771	15:33849	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008945	MF-705
LAPP-TH–					
240-89	15:33505	NTIS (US Sales Only), PC A03/MF A01		DE90792998	
248-89	15:33448	NTIS (US Sales Only), PC A02/MF A01		DE90792999	
LBL–					
15723	15:33858	*See* DOE/TIC–11615			
28672	15:33406	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011216	MF-414
28712	15:33261	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011222	MF-402
28736	15:33407	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011217	MF-413
28753	15:33506	NTIS, PC A03/MF A01; OSTI; INIS		DE90011215	MF-414
28836	15:32977	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011218	MF-414
28863	15:32613	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011214	MF-404
28885	15:32989	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011306	MF-406
28958	15:33262	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011305	MF-403
LESC–					
27642	15:32866	*See* N–90-16013			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
LMF–					
121	15:33223	NTIS, PC A99/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010185	PC-402; PC-407; PC-408
126	15:33224	NTIS, PC A13/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010255	PC-402; PC-407; PC-408
LNCC–					
041/88	15:33709	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627188	
044/88	15:33710	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627189	
048/88	15:33711	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627190	
LP/RB–					
88-15E	15:32443	PC Library of Parliament of Canada, Parliament Buildings, Ottawa, ON, CAN K1A 0A9; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $3.50 CAN; MF $10 CAN			
LPI-CONTRIB–					
691	15:33303	*See* N–90-16607			
LPN–					
89-01	15:33577	NTIS (US Sales Only), PC A03/MF A01		DE90792985	
LPNHEP–					
88-05	15:33449	NTIS (US Sales Only), PC A03/MF A01		DE90792989	
LRP–					
352/88	15:33821	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627475	
381/89	15:33784	NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS		DE90627367	
LUND-MPh–					
89-06	15:33578	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627568	
LYCEN–					
89-11	15:33712	NTIS (US Sales Only), PC A03/MF A01		DE90793000	
MA–					
34SZ.01843-0-CP01	15:32485	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
MHSMP–					
89-27	15:33062	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010342	PC-702
MICROLOG–					
90-01842	15:32443	*See* LP/RB–88-15E			
90-02015	15:32507	*See* OAF/AE–Agdex-440/717.3			
90-02029	15:33066	*See* OME/WRBD–90-02029			
MPI-PAE/Exp.El.–					
214/89	15:33408	NTIS (US Sales Only), PC A12/MF A01		DE90792264	
N–					
90-15146	15:32705	NTIS, PC A03/MF A01			
90-15743	15:32925	NTIS, PC A03/MF A01			
90-15859	15:33297	NTIS, PC A02/MF A01			
90-15860	15:33298	NTIS, PC A02/MF A01			
90-15869	15:33299	NTIS, PC A03/MF A01			
90-15870	15:33300	NTIS, PC A04/MF A01			
90-15871	15:33301	NTIS, PC A02/MF A01			
90-16013	15:32866	NTIS, PC A03/MF A01			
90-16607	15:33303	NTIS, PC A05/MF A01			
90-16664	15:33309	NTIS, PC A03/MF A01			
90-16675	15:33310	NTIS, PC A03/MF A01			
NAGRA-NTB–					
86-05	15:33263	Nagra, CH-5401 Baden, Switzerland			
86-05	15:33264	Nagra, CH-5401 Baden, Switzerland			
86-10	15:33265	Nagra, CH-5401 Baden, Switzerland			
86-19	15:33266	Nagra, CH-5401 Baden, Switzerland			
87-14	15:33267	Nagra, CH-5401 Baden, Switzerland			
87-17	15:33268	Nagra, CH-5401 Baden, Switzerland			
87-19	15:33269	Nagra, CH-5401 Baden, Switzerland			
87-20	15:33270	Nagra, CH-5401 Baden, Switzerland			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
88-03	15:33271	Nagra, CH-5401 Baden, Switzerland			
88-08	15:33272	Nagra, CH-5401 Baden, Switzerland			
88-08	15:33273	Nagra, CH-5401 Baden, Switzerland			
88-23	15:32222	Nagra, CH-5401 Baden, Switzerland			
88-25E	15:32223	Nagra, CH-5401 Baden, Switzerland			
88-30	15:32192	Nagra, CH-5401 Baden, Switzerland			
88-37	15:32224	Nagra, CH-5401 Baden, Switzerland			
88-39	15:33274	Nagra, CH-5401 Baden, Switzerland			
88-40	15:32225	Nagra, CH-5401 Baden, Switzerland			
89-03	15:33129	Nagra, CH-5401 Baden, Switzerland			
89-13	15:32614	Nagra, CH-5401 Baden, Switzerland			
89-14	15:32706	Nagra, CH-5401 Baden, Switzerland			
89-16	15:33275	Nagra, CH-5401 Baden, Switzerland			
89-19	15:32550	Nagra, CH-5401 Baden, Switzerland			
89-25	15:33276	Nagra, CH-5401 Baden, Switzerland			
89-26	15:32226	Nagra, CH-5401 Baden, Switzerland			
NAS–					
1.26:184821	15:33303	*See* N–90-16607			
1.26:185595	15:32866	*See* N–90-16013			
1.26:186188	15:32925	*See* N–90-15743			
1.26:186249	15:32705	*See* N–90-15146			
1.26:186280	15:33300	*See* N–90-15870			
1.26:186281	15:33301	*See* N–90-15871			
1.26:186286	15:33298	*See* N–90-15860			
1.26:186289	15:33297	*See* N–90-15859			
1.26:186290	15:33309	*See* N–90-16664			
1.26:186292	15:33299	*See* N–90-15869			
1.26:186298	15:33310	*See* N–90-16675			
NASA-CR–					
184821	15:33303	*See* N–90-16607			
185595	15:32866	*See* N–90-16013			
186188	15:32925	*See* N–90-15743			
186249	15:32705	*See* N–90-15146			
186280	15:33300	*See* N–90-15870			
186281	15:33301	*See* N–90-15871			
186286	15:33298	*See* N–90-15860			
186289	15:33297	*See* N–90-15859			
186290	15:33309	*See* N–90-16664			
186292	15:33299	*See* N–90-15869			
186298	15:33310	*See* N–90-16675			
NBES–					
2055	15:32515	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
NBI-HE–					
90-01	15:33450	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625644	
90-05	15:33507	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625294	
NIH/PUB–					
90-99-VOL-12-NO-3	15:32280	*See* PB–90-181413/XAB			
NIRS-R–					
17	15:33130	NTIS (US Sales Only), PC A07/MF A01		DE90791338	
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NIRS-RSD–					
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NIST/SP–					
770	15:33631	*See* PB–90-182213/XAB			
NISTIR–					
90/4236	15:32466	*See* PB–90-188095/XAB			
90/4260	15:32465	*See* PB–90-188087/XAB			
NMERDI–					
2-75-5231	15:32133	*See* PB–90-182353/XAB			
NMRDI–					
2-78-5202	15:33218	NTIS, PC A06/MF A01; OSTI; NMRDI, Communications Office, Suite M, 457 Washington SE, Albuquerque, NM 87108		DE90011199	
NORDITA–					
89/51-P(prepr.)	15:33508	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90625297	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
89/59-P(prepr.)	15:33509	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627227	
NRRI–					
90-5	15:32436	OSTI; National Regulatory Research Institute, 1080 Carmack Road, Columbus, OH 43210		TI90010814	
NUREG–					
0750-Vol.30-Index-2	15:32328	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI90011132	
1390	15:32376	NTIS, PC A04/MF A01 - GPO; OSTI; INIS		TI90011138	
1399	15:32322	NTIS, PC A16/MF A01 - GPO; OSTI; INIS		TI90010827	
NUREG/CR–					
4550-Vol.3-Rev.1-Pt.1	15:32414	NTIS, PC A20/MF A01 - GPO; OSTI; INIS		TI90011057	
4550-Vol.3-Rev.1-Pt.2	15:32415	NTIS, PC A99/MF A01 - GPO; OSTI; INIS		TI90011058	
4639-Vol.1-Rev.1	15:32416	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI90011028	
5253	15:32417	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI90011475	
5262	15:32418	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI90011244	
5397	15:32419	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI90011027	
5409	15:32338	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI90010806	
5436-Vol.1	15:32420	NTIS, PC A07/MF A01 - GPO; OSTI; INIS		TI90011492	
5436-Vol.2	15:32421	NTIS, PC A10/MF A01 - GPO; OSTI; INIS		TI90011493	
5468	15:33596	NTIS, PC A04/MF A01 - GPO; OSTI; INIS		TI90011476	
5557	15:32422	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI90011026	
NUREG/IA–					
0023-Vol.1	15:32423	NTIS, PC A07/MF A01 - GPO; OSTI; INIS		TI90010754	
0023-Vol.2	15:32424	NTIS, PC A11/MF A01 - GPO; OSTI; INIS		TI90010755	
NVE-U-R–					
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NVE-V-PUB–					
21	15:32454	NTIS (US Sales Only), PC A03/MF A01		DE90791371	
OAF/AE–					
Agdex-440/717.3	15:32507	PC Ontario Agriculture and Food, Consumer Information Centre, 801 Bay St, Main Floor, Toronto, ON, CAN M7A 2B2; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
OCS/MMS–					
90-0010	15:33188	*See* PNL–7335			
OERR–					
9240.0-04-1	15:32448	*See* PB–90-191545/XAB			
OME/WRBD–					
90-02029	15:33066	PC Ontario Ministry of the Environment, Public Information Office, 135 St. Clair Ave. West, Toronto, ON, CAN M4V 1P5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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3603	15:33067	NTIS, PC A03/MF A01 - OSTI		DE90011087	MF-402
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11180	15:32270	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010272	MF-402
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11510	15:32853	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010335	MF-405
11524	15:32071	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010257	MF-114
OSWER-DIRECTIVE–					
9992.4	15:32447	*See* PB–90-188749/XAB			
OTH–					
89-302	15:32132	H.M. Stationery Office, London, price Pound 25.50			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
PAI–					
CE02994	15:32472	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
PATENTS-USA–					
4878652/A/	15:32859				
4882071/A/	15:33191				
Application7-456,899	15:32433	NTISPC N03/MF A01			
Application7-429,959	15:32697	NTISPC N03/MF A01			
Application7-414,499	15:32905	NTISPC N03/MF A01			
PB–					
90-137100/XAB	15:33142	NTIS, PC A03/MF A01			
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90-164666/XAB	15:32444	NTIS, PC A12/MF A02			
90-165168/XAB	15:32154	NTIS, PC A03/MF A01			
90-166877/XAB	15:33850	NTIS, PC A03/MF A01			
90-167693/XAB	15:32101	NTIS, PC A99/MF A04			
90-167727/XAB	15:32102	NTIS, PC A05/MF A01			
90-167735/XAB	15:32103	NTIS, PC A03/MF A01			
90-169004/XAB	15:32315	NTIS, PC A06/MF A01			
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90-169970/XAB	15:33068	NTIS, PC A12/MF A02			
90-171349/XAB	15:32176	NTIS, PC A11/MF A02			
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90-171992/XAB	15:32317	NTIS, PC A07/MF A01			
90-172313/XAB	15:33069	NTIS, PC A09/MF A01			
90-172628/XAB	15:33070	NTIS, PC A12/MF A02			
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90-178989/XAB	15:32517	NTIS, PC A13/MF A02			
90-179102/XAB	15:33236	NTIS, PC A03/MF A01			
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90-179474/XAB	15:32110	NTIS, PC A10/MF A02			
90-179482/XAB	15:32111	NTIS, PC A05/MF A01			
90-179656/XAB	15:32445	NTIS, PC A05/MF A01			
90-180019/XAB	15:33630	NTIS, PC A08/MF A01			
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Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
90-181306/XAB	15:33148	NTIS, PC A03/MF A01			
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90-181363/XAB	15:33244	NTIS, PC A04/MF A01			
90-181413/XAB	15:32280	NTIS, PC A04/MF A01			
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90-181959/XAB	15:33153	NTIS, PC EE99/MF E99			
90-181967/XAB	15:33154	NTIS, PC A22/MF A03			
90-181975/XAB	15:33155	NTIS, PC A21/MF A03			
90-181983/XAB	15:33156	NTIS, PC A17/MF A03			
90-181991/XAB	15:33157	NTIS, PC A99/MF A04			
90-182007/XAB	15:33158	NTIS, PC A99/MF A04			
90-182015/XAB	15:33159	NTIS, PC A99/MF A04			
90-182023/XAB	15:33160	NTIS, PC A99/MF A04			
90-182049/XAB	15:33161	NTIS, PC A18/MF A03			
90-182056/XAB	15:33162	NTIS, PC A16/MF A02			
90-182213/XAB	15:33631	NTIS, PC A03/MF A01			
90-182338/XAB	15:33313	NTIS, PC A08/MF A01			
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90-183534/XAB	15:33246	NTIS, PC A05/MF A01			
90-183583/XAB	15:33166	NTIS, PC A04/MF A01			
90-183799/XAB	15:33132	NTIS, PC A15/MF A02			
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90-184284/XAB	15:32259	NTIS, PC A11/MF A02			
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90-184896/XAB	15:33085	NTIS, PC A09/MF A01			
90-185000/XAB	15:32104	NTIS, PC A12/MF A02			
90-185059/XAB	15:33169	NTIS, PC A06/MF A01			
90-185133/XAB	15:33170	NTIS, PC A02/MF A01			
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90-185216/XAB	15:33247	NTIS, PC A03/MF A01			
90-185240/XAB	15:33248	NTIS, PC A02/MF A01			
90-185257/XAB	15:33249	NTIS, PC A03/MF A01			
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90-185547/XAB	15:32162	NTIS, PC A11/MF A02			
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90-185844/XAB	15:33087	NTIS, PC A99/MF A04			
90-185927/XAB	15:33171	NTIS, PC A08/MF A01			
90-186172/XAB	15:33172	NTIS, PC A02/MF A01			
90-186180/XAB	15:33173	NTIS, PC A03/MF A01			
90-186206/XAB	15:33174	NTIS, PC A02/MF A01			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
90-186222/XAB	15:33175	NTIS, PC A03/MF A01			
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90-186339/XAB	15:33089	NTIS, PC A04/MF A01			
90-186354/XAB	15:33090	NTIS, PC A14/MF A02			
90-186404/XAB	15:33176	NTIS, PC A03/MF A01			
90-186453/XAB	15:32158	NTIS, PC A04/MF A01			
90-186479/XAB	15:33177	NTIS, PC A05/MF A01			
90-186495/XAB	15:33178	NTIS, PC A06/MF A01			
90-186503/XAB	15:33179	NTIS, PC A08/MF A01			
90-186511/XAB	15:33016	NTIS, PC A03/MF A01			
90-186529/XAB	15:33017	NTIS, PC A03/MF A01			
90-186768/XAB	15:33180	NTIS, PC A04/MF A01			
90-186891/XAB	15:32486	NTIS, PC A15/MF A02			
90-186966/XAB	15:33018	NTIS, PC A01/MF A01			
90-187089/XAB	15:32281	NTIS, PC A03/MF A01			
90-187105/XAB	15:33250	NTIS, PC A03/MF A01			
90-187170/XAB	15:33091	NTIS, PC A04/MF A01			
90-187220/XAB	15:32159	NTIS, PC A06/MF A01			
90-187238/XAB	15:33092	NTIS, PC A06/MF A01			
90-187394/XAB	15:32459	NTIS, PC A03/MF A01			
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90-187469/XAB	15:32460	NTIS, PC A03/MF A01			
90-187964/XAB	15:32526	NTIS, PC A04/MF A01			
90-187972/XAB	15:32181	NTIS, PC A03/MF A01			
90-188038/XAB	15:32461	NTIS, PC A03/MF A01			
90-188087/XAB	15:32465	NTIS, PC A09/MF A02			
90-188095/XAB	15:32466	NTIS, PC A03/MF A01			
90-188749/XAB	15:32447	NTIS, PC A99/MF E06			
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90-190562/XAB	15:32282	NTIS, PC A03/MF A01			
90-191529/XAB	15:33181	NTIS, PC A03/MF A01			
90-191545/XAB	15:32448	NTIS, PC A15/MF A02			
90-191560/XAB	15:32495	NTIS, PC A99/MF A04			
90-191990/XAB	15:33093	NTIS, PC A07/MF A01			
90-501412/XAB	15:33094	NTISCP D03			
90-501479/XAB	15:32449	NTISCP D02			
90-501487/XAB	15:33095	NTISCP D04			
90-501503/XAB	15:32182	NTISCP T02			
90-501560/XAB	15:33096	NTISCP D05			
90-861857/XAB	15:32425	NTISPC N01/MF N01			
90-862244/XAB	15:33182	NTISPC N01/MF N01			
90-862798/XAB	15:33183	NTISPC N01/MF N01			
90-862822/XAB	15:33133	NTISPC N01/MF N01			
90-862863/XAB	15:32518	NTISPC N01/MF N01			
90-862889/XAB	15:33184	NTISPC N01/MF N01			
90-862897/XAB	15:32487	NTISPC N01/MF N01			
90-862947/XAB	15:33185	NTISPC N01/MF N01			
90-862962/XAB	15:32509	NTISPC N01/MF N01			
90-863036/XAB	15:32150	NTISPC N01/MF N01			
90-863226/XAB	15:32510	NTISPC N01/MF N01			
90-863341/XAB	15:32555	NTISPC N01/MF N01			
90-863424/XAB	15:32875	NTISPC N01/MF N01			
90-863465/XAB	15:32867	NTISPC N01/MF N01			
90-863473/XAB	15:33251	NTISPC N01/MF N01			
90-863481/XAB	15:33252	NTISPC N01/MF N01			
90-863507/XAB	15:33097	NTISPC N01/MF N01			
90-863515/XAB	15:33098	NTISPC N01/MF N01			
90-863556/XAB	15:33099	NTISPC N01/MF N01			
90-863606/XAB	15:33100	NTISPC N01/MF N01			
90-863655/XAB	15:32074	NTISPC N01/MF N01			
90-863739/XAB	15:32075	NTISPC N01/MF N01			
90-863762/XAB	15:33045	NTISPC N01/MF N01			
90-863788/XAB	15:33862	NTISPC N01/MF N01			
90-863853/XAB	15:32707	NTISPC N01/MF N01			
90-863887/XAB	15:32708	NTISPC N01/MF N01			
90-863986/XAB	15:32854	NTISPC N01/MF N01			
90-864042/XAB	15:33253	NTISPC N01/MF N01			
90-864075/XAB	15:33254	NTISPC N01/MF N01			
90-864091/XAB	15:33255	NTISPC N01/MF N01			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
90-864133/XAB	15:32556	NTISPC N01/MF N01			
90-864141/XAB	15:33186	NTISPC N01/MF N01			
90-864158/XAB	15:32180	NTISPC N01/MF N01			
90-864166/XAB	15:33187	NTISPC N01/MF N01			
PCCF-T–					
88-12	15:33510	NTIS (US Sales Only), PC A10/MF A01		DE90792881	
88-13	15:33409	NTIS (US Sales Only), PC A09/MF A01		DE90792884	
PIRSEM–					
0253-1	15:32294	NTIS (US Sales Only), PC A12/MF A01		DE90790624	
2027.1	15:32868	NTIS (US Sales Only), PC A09/MF A01		DE90790630	
3008	15:32475	NTIS (US Sales Only), PC A03/MF A01		DE90790629	
3246	15:32283	NTIS (US Sales Only), PC A08/MF A01		DE90790631	
PNC-TN–					
8410-89-047	15:33603	NTIS (US Sales Only), PC A05/MF A01		DE90791115	
PNCT-N–					
9410-89-112	15:32869	NTIS (US Sales Only), PC A03/MF A01		DE90791140	
9410-89-159	15:32870	NTIS (US Sales Only), PC A04/MF A01		DE90791141	
PNL–					
6415-Rev.2	15:33101	NTIS, PC A11/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011056	MF-600
6450-30-HEDR	15:33102	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010835	MF-707
6931	15:32419	*See* NUREG/CR–5397			
6985	15:32227	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011055	MF-702; MF-721
7167	15:32198	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010319	MF-722
7176	15:32482	*See* DOE/BP/13795–23			
7209	15:32228	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010859	MF-510
7229	15:32229	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010313	MF-602
7258	15:32230	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010854	MF-721
7309	15:32511	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010281	MF-313
7332	15:33219	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010858	
7335	15:33188	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010857	
7336	15:32231	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010853	MF-512
7341	15:32232	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010852	MF-721
PNL-SA–					
17482	15:32467	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010256	MF-900
PPPL–					
2666	15:33785	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010344	PC-420
PREPRINT-SERIES–					
232	15:33298	*See* N–90-15860			
240	15:33297	*See* N–90-15859			
288	15:33299	*See* N–90-15869			
293	15:33309	*See* N–90-16664			
314	15:33300	*See* N–90-15870			
316	15:33301	*See* N–90-15871			
PSR–					
1952	15:32528	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010841	MF-700
PWA–					
71/89	15:32257	*See* KFK–4680			
PWC/SPO–					
CE02985	15:32289	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
RAE–					
8810-6	15:33140	*See* DOE/ER/60664–5			
REPT–					
83-102	15:32866	*See* N–90-16013			
89-62529	15:32477	*See* PB–90-183237/XAB			
RERF-TR–					
11-89	15:33604	NTIS (US Sales Only), PC A03/MF A01		DE90791088	
3-89	15:33227	NTIS (US Sales Only), PC A02/MF A01		DE90791086	
4-89	15:33228	NTIS (US Sales Only), PC A03/MF A01		DE90791085	
7-89	15:33229	NTIS (US Sales Only), PC A03/MF A01		DE90791087	
RFP–					
4292	15:32233	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010190	PC-721
4410	15:32234	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010807	MF-711
RRK–					
89-28	15:33315	NTIS (US Sales Only), PC A10/MF A01		DE90791308	
90-1	15:33478	NTIS (US Sales Only), PC A03/MF A01		DE90791139	
SAAS-Mitt–					
89-11	15:33605	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90628021	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
SAIC–					
90/1130-Vol.1	15:32420	*See* NUREG/CR–5436-Vol.1			
90/1130-Vol.2	15:32421	*See* NUREG/CR–5436-Vol.2			
SAND–					
86-2084-Vol.3-Rev.1-Pt.1	15:32414	*See* NUREG/CR–4550-Vol.3-Rev.1-Pt.1			
86-2084-Vol.3-Rev.1-Pt.2	15:32415	*See* NUREG/CR–4550-Vol.3-Rev.1-Pt.2			
87-0959	15:33021	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010323	MF-705
88-0558	15:32235	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010300	MF-814
88-1958	15:32496	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010273	
88-2940	15:32417	*See* NUREG/CR–5253			
88-3093	15:32418	*See* NUREG/CR–5262			
89-0126C	15:33008	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010534	MF-706
89-0201	15:32236	NTIS, PC A04/MF A01; OSTI; INIS		DE90010322	MF-510
89-2229C	15:32440	NTIS, PC A02/MF A01 - OSTI		DE90010659	MF-212
89-2342C	15:32441	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009740	MF-213
89-2389C	15:32709	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010846	MF-706
89-2405	15:33822	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008237	PC-420; PC-421; PC-422; PC-423;
89-2500	15:32855	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010324	MF-705
89-2561C	15:32856	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009001	MF-706
89-2658	15:33000	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010275	MF-700
89-3001C	15:32710	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011234	MF-404
89-3086C	15:32290	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006280	MF-237
89-7045	15:32284	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010330	MF-274
89-7151	15:32273	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010325	MF-125
89-8253	15:32993	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010331	MF-406
90-0001C	15:33025	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009974	
90-0005C	15:32437	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009729	MF-704
90-0088C	15:32711	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009743	MF-704
90-0125C	15:33026	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011051	MF-706
90-0161C	15:33042	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006770	MF-706
90-0164C	15:33009	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011050	MF-706
90-0226C	15:33043	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006769	MF-706
90-0230C	15:32871	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010833	MF-742
90-0285	15:32237	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010329	MF-721
90-0339	15:32965	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010298	MF-900
90-0341C	15:32557	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007167	MF-704
90-0344C	15:32985	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007285	MF-706
90-0348C	15:32857	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011020	MF-706
90-0352C	15:32858	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011025	MF-706
90-0367C	15:32986	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007152	MF-706
90-0368C	15:32881	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007413	MF-706
90-0388	15:33027	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010299	MF-742
90-0394C	15:32937	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007073	MF-700
90-0410C	15:32987	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007288	MF-706
90-0436C	15:32882	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007679	MF-706
90-0464C	15:32184	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010825	MF-123
90-0480C	15:33853	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007678	MF-705; MF-706
90-0501C	15:32988	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008345	MF-706
90-0506C	15:32873	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009744	MF-741
90-0519	15:33036	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010328	MF-600
90-0577C	15:33028	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011052	MF-706
90-0869	15:33863	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010297	MF-700
90-1075C	15:32299	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009742	MF-253
90-1077C	15:32712	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010831	MF-704
90-1111C	15:32615	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011048	MF-704
90-1177C	15:32713	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010848	MF-704
90-1209C	15:32883	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010657	MF-706
90-1229C	15:32616	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011236	MF-704
90-1265C	15:33632	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011018	MF-410
90-8216	15:33022	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010327	MF-705
90-8223	15:32118	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010326	MF-113
SERI/TP–					
257-3455	15:32305	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89009505	MF-261
257-3695	15:32306	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000327	MF-261

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
SGD–					
543-PT-1	15:33311	*See* PB–90-156886/XAB			
544-PT-1	15:33312	*See* PB–90-171661/XAB			
545-PT-1	15:33313	*See* PB–90-182338/XAB			
545-PT-2	15:33314	*See* PB–90-182346/XAB			
SJF-Orientering–					
65	15:32271	NTIS (US Sales Only), PC A03/MF A01		DE90791324	
SKB-TR–					
89-18	15:32238	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90628289	
SL–					
1271-87828	15:32307	NTIS (US Sales Only), PC A06/MF A01		DE90791318	
SLAC–					
358	15:33277	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010334	PC-403
361	15:33398	NTIS, PC A25/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010312	PC-414
SLAC-PUB–					
5211	15:32938	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010308	MF-414
5214	15:32978	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010182	MF-414
5226	15:32910	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010311	MF-414
5236	15:33410	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010309	MF-414
5243	15:32939	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010310	MF-414
SNM-BAC–					
89/1	15:32105	Milieuboek, Henri Polaklaan 42, NL-1018 CT Amsterdam, the Netherlands			
SSI–					
89-12	15:33606	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90628030	
SSSU–					
38	15:32308	the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
STI–					
96030-810FR	15:33093	*See* PB–90-191990/XAB			
SUPRI-TR–					
72	15:32129	*See* DOE/BC/14126–18			
SwRI–					
12-6253	15:32435	*See* DOE/RA/50219–T10			
TRITA-PFU–					
88-11	15:33786	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627358	
TSHUNE–					
0001	15:32330	*See* CNIC–00129			
TTC–					
0969	15:32198	*See* PNL–7167			
U03-HAU–					
0019	15:33217	*See* CNIC–00199			
UCB-PTH–					
90/09	15:33506	*See* LBL–28753			
UCID–					
16986-89-2/3/4	15:32186	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010282	MF-123
21849-Rev.1	15:33823	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010332	MF-712
21937	15:32961	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010350	MF-414
UCRL–					
100211	15:32239	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011467	MF-814
100808	15:32714	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010743	MF-700
100841	15:32297	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010742	MF-250
101292	15:33044	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010756	
101659	15:32979	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010741	MF-706
101690	15:32558	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010687	MF-704
101735	15:33103	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010677	MF-603
101997	15:33104	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010676	MF-702
101998	15:33105	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010865	MF-702
102201	15:32884	NTIS, PC A03/MF A01 - OSTI		DE90010746	MF-706
102393	15:33029	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009436	MF-741
102395	15:33030	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011463	MF-741
102494	15:32789	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005998	MF-800
102495	15:32519	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005992	MF-333
102496	15:32520	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005993	MF-333
102497-1	15:32167	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005991	MF-333
102578	15:33031	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010677	MF-701; MF-706

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
102584	15:32836	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006002	MF-104
102623	15:32940	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010678	
102667	15:32885	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010747	MF-706
102737-Rev.1	15:33854	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010679	MF-405
102758	15:32715	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011204	MF-704
102778	15:32837	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007856	MF-361
102785	15:33106	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010688	MF-706; MF-721
102927	15:32497	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010681	
102982	15:32941	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010864	MF-700
102983	15:32942	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010868	MF-700
102985	15:33196	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010869	MF-700
102986	15:32943	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010867	MF-700
102987	15:32944	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010870	MF-700
21221	15:33134	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011014	
21223-App.	15:33230	NTIS, PC A24/MF A01 - OSTI		DE90010762	MF-702
21239	15:33037	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008783	MF-700
52000-90-3	15:32529	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008230	PC-700
UCRL-CR–					
103263	15:33001	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010695	MF-706; MF-702
103860	15:32886	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010757	MF-706
UCRL-ID–					
103202	15:33855	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010173	
103271	15:33386	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010354	MF-704
103470	15:32980	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010285	MF-706
103473	15:33787	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010352	MF-420
103480	15:32530	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010286	MF-700
103486	15:33824	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010287	MF-506
103611	15:33387	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010349	MF-362
103766	15:33038	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010288	MF-706
UCRL-JC–					
103244	15:33032	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009438	MF-701; MF-706
103302	15:32887	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010682	MF-706; MF-705
103431	15:33107	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010694	MF-412; MF-402
103498	15:33039	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010689	MF-742
103512	15:33033	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010683	MF-706
103579	15:33388	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010637	MF-706
103591	15:33108	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010866	MF-700
103626	15:33034	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010633	MF-712
103630	15:32716	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010873	MF-404
103865	15:33451	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010871	MF-700
103872	15:32808	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011230	MF-700
103969	15:33109	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010638	
UILU-ENG–					
90-1726	15:33844	*See* DOE/ER/25026–35			
UIUCDCS-R–					
90-1587	15:33844	*See* DOE/ER/25026–35			
UJV–					
8308-F,R	15:32355	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90625093	
8653-T	15:32325	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90628207	
8731-V	15:33835	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90628335	
UM–					
025921-8-T	15:32705	*See* N–90-15146			
UNC-WRRI–					
89-246	15:33169	*See* PB–90-185059/XAB			
89-248	15:33180	*See* PB–90-186768/XAB			
UR–					
1101	15:33433	*See* DOE/ER/13065–568			
USDA/AER–					
626	15:32457	*See* PB–90-183179/XAB			
USGS–					
90-113	15:32240	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010656	MF-814
USGS-BULL–					
1912	15:32126	*See* PB–90-181439/XAB			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
89-4107	15:32460	*See* PB–90-187469/XAB			
USGS-OFR–					
90-31	15:32717	OSTI; USGS-OFR, USGS Open File Service, Box 25425-Denver Federal Center, Denver, CO 80225		TI90010879	MF-703
USGS/MAP/I–					
2047	15:33278	OSTI; USGS, Map Distribution, Box 25286, Federal Center, Denver, CO 80225		TI90010900	
USGS/WRI–					
89-4102	15:33164	*See* PB–90-182726/XAB			
89-4172	15:33152	*See* PB–90-181868/XAB			
UTAP–					
107/90	15:33288	*See* FERMILAB-PUB–90/52-A			
UTNL-R–					
239	15:33825	NTIS (US Sales Only), PC A07/MF A01		DE90791319	
WHC-EP–					
0359	15:33135	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010316	MF-602
WHC-SA–					
0881	15:32262	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010851	MF-528
WMO–					
16	15:33078	*See* PB–90-181504/XAB			
WSRC-RP–					
89-1348	15:32242	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011249	MF-721
89-901	15:32241	NTIS, PC A03/MF A01 - OSTI		DE90011239	MF-721
WVDP–					
90AR	15:32243	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010336	PC-510
YEDT–					
3766-4-3	15:32488	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
3766-4-9	15:32489	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			

Order Number Correlation

The correlation list is provided for those organizations that file documents by report number but may receive requests by order number. For more information about a document, refer to the Report Number Index.

Order No.	Report No.
DE83012853	DOE/TIC–11615
DE89009505	SERI/TP–257-3455
DE90000234	DOE/BC/14126–18
DE90000327	SERI/TP–257-3695
DE90000441	DOE/MC/22065–2809
DE90000459	DOE/MC/11076–2795
DE90000465	DOE/MC/21353–2805
DE90000467	DOE/MC/11076–2807
DE90000468	DOE/MC/24051–2808
DE90000473	DOE/MC/20213–2816-Vol.1
DE90000474	DOE/MC/20213–2816-Vol.2
DE90000475	DOE/MC/20213–2816-Vol.3
DE90000478	DOE/MC/05564–2815
DE90002686	DOE/ER–0428
DE90003063	CONF-900729–1
DE90003546	CONF-891098–3
DE90003717	CONF-900737–1
DE90005280	CONF-900729–2
DE90005991	UCRL–102497-1
DE90005992	UCRL–102495
DE90005993	UCRL–102496
DE90005998	UCRL–102494
DE90006002	UCRL–102584
DE90006280	SAND–89-3086C
DE90006312	CONF-900704–7
DE90006769	SAND–90-0226C
DE90006770	SAND–90-0161C
DE90007073	SAND–90-0394C
DE90007134	EGG–10617-1040
DE90007152	SAND–90-0367C
DE90007167	SAND–90-0341C
DE90007227	DOE/ER/40315–T1
DE90007285	SAND–90-0344C
DE90007288	SAND–90-0410C
DE90007413	SAND–90-0368C
DE90007571	CONF-900704–6
DE90007678	SAND–90-0480C
DE90007679	SAND–90-0436C
DE90007792	CONF-900765–1
DE90007856	UCRL–102778
DE90008230	UCRL–52000-90-3
DE90008237	SAND–89-2405
DE90008251	DOE/PC/91022–T5
DE90008345	SAND–90-0501C
DE90008372	CONF-900764–1
DE90008418	DOE/ER/45167–2
DE90008557	CONF-900774–1
DE90008568	CONF-900775–1
DE90008572	CONF-900773–1
DE90008783	UCRL–21239
DE90008945	LA-UR–90-771
DE90008964	LA-UR–90-753
DE90009001	SAND–89-2561C
DE90009022	CONF-900704–9
DE90009236	CONF-900724–4
DE90009237	CONF-900724–2
DE90009238	CONF-900724–3
DE90009239	CONF-900724–1
DE90009409	CONF-900789–1
DE90009421	CONF-900724–5
DE90009422	CONF-900724–6
DE90009423	CONF-900724–7
DE90009436	UCRL–102393
DE90009438	UCRL-JC–103244
DE90009703	CONF-900793–1
DE90009719	CONF-9002120–1
DE90009723	CONF-900102–5
DE90009729	SAND–90-0005C
DE90009740	SAND–89-2342C
DE90009742	SAND–90-1075C
DE90009743	SAND–90-0088C
DE90009744	SAND–90-0506C
DE90009749	LA-UR–90-1332
DE90009779	EGG-M–90027
DE90009974	SAND–90-0001C
DE90010016	BNL–44410
DE90010046	CONF-9004194–1
DE90010099	CONF-9004182–1
DE90010146	CONF-900742–1
DE90010173	UCRL-ID–103202
DE90010182	SLAC-PUB–5214
DE90010185	LMF–121
DE90010190	RFP–4292
DE90010201	ANL/APS-TM–5
DE90010234	EGG–2591
DE90010253	LA–11808-C
DE90010255	LMF–126
DE90010256	PNL-SA–17482
DE90010257	ORNL/TM–11524
DE90010258	DOE/BP/13795–23
DE90010261	LA–11765-MS
DE90010262	ANL–89/35
DE90010263	LA–11743-MS
DE90010272	ORNL/TM–11180
DE90010273	SAND–88-1958
DE90010275	SAND–89-2658
DE90010276	DOE/FE–0183P
DE90010281	PNL–7309
DE90010282	UCID–16986-89-2/3/4
DE90010285	UCRL-ID–103470
DE90010286	UCRL-ID–103480
DE90010287	UCRL-ID–103486
DE90010288	UCRL-ID–103766
DE90010289	DOE/SR-WM–90-1
DE90010290	DOE/FE–0172P
DE90010291	DOE/MA–0412
DE90010292	DOE/MA–0411
DE90010293	DOE/EH–0116
DE90010294	DOE/EH–0126
DE90010297	SAND–90-0869
DE90010298	SAND–90-0339
DE90010299	SAND–90-0388
DE90010300	SAND–88-0558
DE90010301	ORNL/TM–11356
DE90010303	ANL–90/7
DE90010304	ANL/EAIS/TM–10
DE90010305	ANL/ESD–3
DE90010306	DOE/ER/53198–154
DE90010308	SLAC-PUB–5211
DE90010309	SLAC-PUB–5236
DE90010310	SLAC-PUB–5243
DE90010311	SLAC-PUB–5226
DE90010312	SLAC–361
DE90010313	PNL–7229
DE90010314	DOE/FE–0178P
DE90010315	ORNL/M–1073
DE90010316	WHC-EP–0359
DE90010317	DOE/RL–89-26
DE90010318	ERCE-R–89-42
DE90010319	PNL–7167
DE90010321	DOE/ER–0432
DE90010322	SAND–89-0201
DE90010323	SAND–87-0959
DE90010324	SAND–89-2500
DE90010325	SAND–89-7151
DE90010326	SAND–90-8223
DE90010327	SAND–90-8216
DE90010328	SAND–90-0519
DE90010329	SAND–90-0285
DE90010330	SAND–89-7045
DE90010331	SAND–89-8253
DE90010332	UCID–21849-Rev.1
DE90010333	DOE/ER/53222–102
DE90010334	SLAC–358
DE90010335	ORNL/TM–11510
DE90010336	WVDP–90AR
DE90010341	LA–11776-MS
DE90010342	MHSMP–89-27
DE90010344	PPPL–2666
DE90010349	UCRL-ID–103611
DE90010350	UCID–21937
DE90010352	UCRL-ID–103473
DE90010354	UCRL-ID–103271
DE90010438	CONF-900758–1
DE90010439	CONF-900466–35
DE90010440	CONF-900563–1
DE90010444	CONF-8306308–
DE90010464	CONF-900789–2
DE90010493	CONF-900742–2
DE90010496	CONF-900466–34
DE90010500	CONF-900704–10
DE90010502	CONF-8908191–3
DE90010522	DOE/CE/15444–T2
DE90010534	SAND–89-0126C
DE90010542	CONF-8910367–2
DE90010561	DOE/EA–0396
DE90010574	DOE/ID/12756–1
DE90010580	CONF-9005168–1
DE90010598	LA-UR–90-1329
DE90010599	LA-UR–90-1333
DE90010600	LA-UR–90-1338
DE90010609	LA-UR–90-1372
DE90010619	LA-UR–90-1438
DE90010633	UCRL-JC–103626
DE90010637	UCRL-JC–103579
DE90010638	UCRL-JC–103969
DE90010640	DOE/ID–10281
DE90010641	BNL–44466
DE90010642	BNL–44454
DE90010643	BNL-NUREG–44506
DE90010645	BNL–43273
DE90010647	BNL–43691
DE90010650	BNL–44536

Order No.	Report No.
DE90010651	BNL–44496
DE90010656	USGS–90-113
DE90010657	SAND–90-1209C
DE90010659	SAND–89-2229C
DE90010667	DOE/ER/13435–4
DE90010676	UCRL–101997
DE90010677	UCRL–102578
DE90010678	UCRL–102623
DE90010679	UCRL–102737-Rev.1
DE90010681	UCRL–102927
DE90010682	UCRL-JC–103302
DE90010683	UCRL-JC–103512
DE90010687	UCRL–101690
DE90010688	UCRL–102785
DE90010689	UCRL-JC–103498
DE90010694	UCRL-JC–103431
DE90010695	UCRL-CR–103263
DE90010696	DOE/NBB–0071-Vol.1
DE90010697	DOE/NBB–0071-Vol.2
DE90010698	DOE/NBB–0071-Vol.3
DE90010701	CONF-900512–2
DE90010703	CONF-9006139–1
DE90010705	CONF-900795–1
DE90010706	CONF-900512–1
DE90010710	CONF-9005172–1
DE90010714	CONF-9005171–1
DE90010716	CONF-9005169–1
DE90010717	CONF-9006173–1
DE90010719	CONF-900780–2
DE90010721	CONF-881054–49
DE90010741	UCRL–101659
DE90010742	UCRL–100841
DE90010743	UCRL–100808
DE90010746	UCRL–102201
DE90010747	UCRL–102667
DE90010756	UCRL–101292
DE90010757	UCRL-CR–103860
DE90010762	UCRL–21223-App.
DE90010790	DOE/ER/13950–2
DE90010791	DOE/ER/13591–4
DE90010807	RFP–4410
DE90010809	DOE/RA/50219–T10
DE90010811	DOE/ER/13542–4
DE90010816	LA–11762-MS
DE90010825	SAND–90-0464C
DE90010826	DOE/HWP–99
DE90010831	SAND–90-1077C
DE90010833	SAND–90-0230C
DE90010835	PNL–6450-30-HEDR
DE90010838	ORNL/FTR–3604
DE90010840	EGG–10617-1081
DE90010841	PSR–1952
DE90010846	SAND–89-2389C
DE90010848	SAND–90-1177C
DE90010849	KCP–613-4215
DE90010851	WHC-SA–0881
DE90010852	PNL–7341
DE90010853	PNL–7336
DE90010854	PNL–7258
DE90010857	PNL–7335
DE90010858	PNL–7332
DE90010859	PNL–7209
DE90010860	DOE/RL–89-10
DE90010864	UCRL–102982
DE90010865	UCRL–101998
DE90010866	UCRL-JC–103591
DE90010867	UCRL–102986
DE90010868	UCRL–102983
DE90010869	UCRL–102985
DE90010870	UCRL–102987
DE90010871	UCRL-JC–103865
DE90010873	UCRL-JC–103630
DE90010877	UCRL–101735
DE90010880	DOE/ER/14004–1
DE90010884	EGG-M–90200
DE90010891	CONF-870811–Vol.2
DE90010895	K/QT–222
DE90010901	DOE/ER/14011–1
DE90010903	EGG-M–89114
DE90010904	EGG-M–89251
DE90010905	EGG-M–90189
DE90010909	ANL/ESH/TS–90/101
DE90010910	DOE/ER/00038–3288
DE90010915	EGG-EP–9029
DE90010916	EGG-M–90151
DE90010917	EGG-M–89060
DE90010918	EGG-M–88503
DE90010922	EGG-M–89412
DE90010925	DOE/OR/00033–T38
DE90010926	EGG-EP–8919
DE90010927	EGG-EP–8954
DE90010928	EGG-EAST–8680
DE90010932	EGG-M–89219
DE90010934	EGG-M–88444
DE90010935	DOE/EIA–0121(89/4Q)
DE90010936	EGG-NPD–8836
DE90010937	EGG-NPD–8837
DE90010938	EGG-M–89329
DE90010942	EGG-M–89074
DE90010943	EGG-M–89075
DE90010945	EGG-M–89276
DE90010946	EGG-M–89148
DE90010947	EGG-M–89393
DE90010948	EGG-M–89267
DE90010949	EGG-M–89151
DE90010950	EGG-M–89144
DE90010951	EGG-M–89160
DE90010952	EGG-M–89113
DE90010954	EGG-BNCT–8777-Vol.4-No.3
DE90010957	DOE/ER/45341–3
DE90010958	DOE/ER/60372–5
DE90010959	DOE/ER/13729–2
DE90010960	DOE/ER/13255–6
DE90010963	DOE/ER/13631–17
DE90010966	DOE/ER/13595–T1
DE90010972	DOE/PC/89904–T10
DE90010975	DOE/EIA–0380(90/02)
DE90010976	EGG-CEMA–8185
DE90010978	EGG-ER–8686
DE90010979	EGG-EG–8893
DE90010980	EGG-M–89360
DE90010981	EGG-M–90162
DE90010982	EGG-M–89464
DE90010983	EGG-M–89106
DE90010987	EGG-M–89295
DE90010988	EGG-M–89221
DE90010992	DOE/ER/25026–35
DE90010993	DOE/ER/13370–1
DE90010997	DOE/ER/13942–2
DE90011000	BNL–43811-Rev.
DE90011001	BNL–44522
DE90011004	DOE/PC/88935–T5
DE90011005	DOE/PC/90015–T1-Vol.6
DE90011006	DOE/PC/90015–T1-Vol.9
DE90011007	DOE/PC/90015–T1-Vol.12
DE90011008	DOE/PC/90015–T4
DE90011009	DOE/PC/90015–T5
DE90011010	DOE/PC/90015–T6
DE90011011	DOE/PC/90015–T7
DE90011012	DOE/PC/90015–T8
DE90011013	DOE/ER/13065–568
DE90011014	UCRL–21221
DE90011018	SAND–90-1265C
DE90011020	SAND–90-0348C
DE90011025	SAND–90-0352C
DE90011029	DOE/PO/10391–T1
DE90011031	DOE/PO/07196–T1
DE90011032	DOE/PO/07196–T2
DE90011036	DOE/PC/88917–T4
DE90011037	DOE/PC/89904–T11
DE90011038	ORNL/FTR–3606
DE90011040	ORNL/FTR–3609
DE90011041	ORNL/FTR–3600
DE90011042	DOE/ER/52147–3
DE90011044	K/TR–90/1
DE90011046	ALS/TR–90-008
DE90011048	SAND–90-1111C
DE90011050	SAND–90-0164C
DE90011051	SAND–90-0125C
DE90011052	SAND–90-0577C
DE90011054	DOE/ET/53088–432
DE90011055	PNL–6985
DE90011056	PNL–6415-Rev.2
DE90011061	CONF-900780–3
DE90011063	CONF-9004197–1
DE90011064	CONF-900466–37
DE90011068	CONF-900546–1
DE90011070	DOE/ER/53267–3
DE90011071	DOE/ER/10666–8
DE90011072	DOE/ER/53266–32
DE90011075	CONF-900623–7
DE90011076	CONF-9004159–7
DE90011078	CONF-8906270–5
DE90011079	DOE/ER/52147–T1
DE90011080	DOE/ER/52147–T2
DE90011081	DOE/PC/88934–T5
DE90011087	ORNL/FTR–3603
DE90011088	DOE/SR/18047–2
DE90011089	ORNL/FTR–3608
DE90011090	CONF-900634–1
DE90011091	CONF-9004110–2
DE90011092	CONF-900546–2
DE90011097	CONF-8909331–1
DE90011099	CONF-9003154–2
DE90011105	DOE/RL–88-04-Rev.2
DE90011106	CONF-900623–10
DE90011107	ANL-HEP-CP–90-33
DE90011109	CONF-900709–1
DE90011111	CONF-900466–38
DE90011112	ANL-HEP-CP–90-34
DE90011114	CONF-900623–8
DE90011115	CONF-900623–9
DE90011116	CONF-900676–4
DE90011117	CONF-9006169–2
DE90011118	CONF-900676–5
DE90011120	DOE/ER/13933–T1
DE90011121	BNL–44583
DE90011122	BNL–44606
DE90011124	FERMILAB-PUB–90/44-A
DE90011125	FERMILAB-PUB–89/223-A
DE90011126	FNAL/Pub–90/56-A
DE90011127	FERMILAB-PUB–90/52-A
DE90011128	FERMILAB-PUB–90/69-A
DE90011129	FERMILAB-PUB–90/47-A
DE90011130	FERMILAB-PUB–90/64-A
DE90011137	ANL/ESH/TS–90/103
DE90011140	DOE/ID/12735–T8
DE90011143	DOE/PC/88913–T5
DE90011145	CONF-9004133–3
DE90011152	CONF-900676–6
DE90011153	CONF-900418–15
DE90011154	CONF-891007–120
DE90011160	CONF-9006105–1
DE90011161	CONF-900432–1
DE90011163	CONF-900402–7
DE90011170	CONF-891204–33

Order No.	Report No.
DE90011171	CONF-900617–14
DE90011177	CONF-900190–1
DE90011178	CONF-891119–132
DE90011182	CONF-9004181–2
DE90011185	DOE/ER/40304–6
DE90011186	DOE/MC/25009–2838
DE90011187	DOE/MC/24267–2837
DE90011190	EGG–10617-1031
DE90011191	EGG–10617-1044
DE90011192	EGG–10617-2062
DE90011193	EGG–10617-2066
DE90011195	DOE/S–0074
DE90011199	NMRDI-2-78-5202
DE90011202	BNL–43413
DE90011204	UCRL–102758
DE90011205	EGG–10617-1056-Vol.1
DE90011206	EGG–10617-1052
DE90011207	EGG–10617-1056-Vol.2
DE90011208	EGG–10617-1059
DE90011209	EGG–10617-1058
DE90011210	EGG–10617-1068
DE90011211	EGG–10617-1053
DE90011212	EGG–10617-1051
DE90011213	EGG–10617-1054
DE90011214	LBL–28863
DE90011215	LBL–28753
DE90011216	LBL–28672
DE90011217	LBL–28736
DE90011218	LBL–28836
DE90011220	EGG–10617-1055
DE90011221	EGG–10617-1057
DE90011222	LBL–28712
DE90011230	UCRL-JC–103872
DE90011234	SAND–89-3001C
DE90011236	SAND–90-1229C
DE90011239	WSRC-RP–89-901
DE90011240	DPST–71-317
DE90011241	DP-MS–89-78
DE90011243	DOE/NV–317
DE90011248	DPST–87-891
DE90011249	WSRC-RP–89-1348
DE90011251	DPST–88-910
DE90011302	DPST–82-492
DE90011305	LBL–28958
DE90011306	LBL–28885
DE90011309	ORNL/FTR–3613
DE90011313	CONF-9004201–1
DE90011318	CONF-900519–1
DE90011321	CONF-900302–1
DE90011333	CONF-900466–45
DE90011335	ANL-Trans–89-52
DE90011381	CONF-900582–1
DE90011390	CONF-900505–2
DE90011403	DOE/MC/10637–2827-Task-2.2
DE90011404	DOE/MC/10637–2827-Task-2.1
DE90011418	DOE/ER/60664–5
DE90011421	DOE/ER/45373–2
DE90011432	DOE/ER/53236–T2
DE90011442	DOE/ER/53295–1
DE90011444	DOE/ER/60871–1
DE90011463	UCRL–102395
DE90011467	UCRL–100211
DE90625093	UJV–8308-F,R
DE90625294	NBI-HE–90-05
DE90625297	NORDITA–89/51-P(prepr.)
DE90625340	IFUSP-P–779
DE90625445	JET-R–(89)16
DE90625514	ANU-PRL-PP–89/8
DE90625560	ANU-PRL-PP–89/6
DE90625644	NBI-HE–90-01
DE90625825	IFUSP-P–792
DE90625914	IFUSP-P–774
DE90626625	IPEN-PUB–283
DE90626916	CNIC–00236
DE90626993	CTA-IEAv-NT–004/89
DE90627149	IC–89/329
DE90627150	IC–89/342
DE90627151	IC–89/395
DE90627152	IC–89/396
DE90627153	IC–89/397
DE90627154	IC–89/398
DE90627155	IC–89/410
DE90627156	IC–89/411
DE90627157	IC–89/412
DE90627158	IC–89/422
DE90627159	IC–89/428
DE90627160	IC–89/432
DE90627161	IC–89/434
DE90627162	IC–90/10
DE90627163	IC–90/13
DE90627164	IC–90/14
DE90627165	IC–90/16
DE90627166	IC–90/3
DE90627167	IC–90/31
DE90627168	IC–90/34
DE90627169	IC–90/35
DE90627170	IC–90/4
DE90627171	IC–90/40
DE90627172	IC–90/9
DE90627174	CBPF-NF–029/89
DE90627175	CBPF-NF–030/89
DE90627176	CBPF-NF–037/89
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DE90627178	IC–89/277
DE90627179	IC–89/388
DE90627180	IC–89/394
DE90627181	IC–89/425
DE90627182	IC–90/23
DE90627183	IFT-P–27/89
DE90627184	IFT-P–28/89
DE90627185	IFT-P–29/89
DE90627187	KFKI–1989-53/A
DE90627188	LNCC–041/88
DE90627189	LNCC–044/88
DE90627190	LNCC–048/88
DE90627194	CBPF-NF–048/89
DE90627195	IC–89/379
DE90627196	IC–89/392
DE90627197	IC–90/17
DE90627198	IC–90/19
DE90627199	IC–90/39
DE90627203	KFKI–1989-52/B
DE90627204	KFKI–1989-55/B
DE90627206	IC–89/190
DE90627207	IC–89/319
DE90627208	IC–89/321
DE90627209	IC–89/372
DE90627210	IC–89/374
DE90627211	IC–89/399
DE90627212	IC–89/423
DE90627213	IC–89/424
DE90627214	IC–89/429
DE90627215	IC–89/431
DE90627216	IC–90/11
DE90627217	IC–90/20
DE90627218	IC–90/21
DE90627219	IC–90/22
DE90627220	IC–90/33
DE90627221	IC–90/41
DE90627222	IC–90/5
DE90627223	IC–90/7
DE90627224	IFT-P–03/89
DE90627226	KFKI–1989-45/A
DE90627227	NORDITA–89/59-P(prepr.)
DE90627276	CBPF-NF–033/89
DE90627277	CBPF-NF–035/89
DE90627278	CBPF-NF–043/89
DE90627279	CBPF-NF–047/89
DE90627291	CBPF-NF–014/89
DE90627292	IC–89/228
DE90627293	IC–89/320
DE90627294	IC–89/325
DE90627305	KFKI–1989-54/A
DE90627313	IC–89/389
DE90627314	IC–89/391
DE90627315	IC–89/400
DE90627316	IC–89/401
DE90627317	IC–89/407
DE90627318	IC–89/417
DE90627319	IC–90/2
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DE90627321	CBPF-NF–039/89
DE90627322	CBPF-NF–040/89
DE90627323	CBPF-NF–041/89
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DE90627325	IC–89/317
DE90627338	CBPF-NF–045/89
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DE90627493	IC–89/427
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DE90627507	IC–89/313
DE90627508	IC–89/380
DE90627510	IC–89/384
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DE90627512	IFT-P–26/89
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DE90627522	CBPF-NF–044/89
DE90627523	IC–89/415
DE90627524	IFT-P–19/89
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DE90627527	KFKI–1989-48/A
DE90627537	IFT-P–30/89
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DE90627590	KFKI–1989-40/A
DE90627591	CBPF-NF–024/89
DE90627592	IC–89/433
DE90627686	CBPF-NF–031/86
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DE90627756	CNIC–00237
DE90627792	IC–89/418
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DE90627871	CBPF-NF–028/89
DE90627888	IC–89/406
DE90627893	CNIC–00257
DE90627922	IC–89/244

Order No.	Report No.
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DE90628023	CNIC–00223
DE90628030	SSI–89-12
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DE90628169	KFKI–1989-46/G
DE90628207	UJV–8653-T
DE90628209	KFKI–1989-42/I
DE90628279	CBPF-NT–001/89
DE90628280	CBPF-NT–004/89
DE90628281	IC–89/421
DE90628289	SKB-TR–89-18
DE90628307	CNIC–00129
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DE90628323	INIS-XN–232
DE90628330	INIS-mf–12597
DE90628335	UJV–8731-V
DE90784648	CEA-CONF–9979
DE90784654	FRCEA-TH–235
DE90785070	DESY-F–35-90-01
DE90786127	ECN-RX–90-003
DE90786186	Bouwcentrum–11786
DE90790592	FRCEA-TH–2317
DE90790593	IFP–37-479
DE90790598	FRNC-TH–3557
DE90790600	FRNC-TH–3553
DE90790624	PIRSEM–0253-1
DE90790625	AFME–85.05.1016
DE90790626	AFME–85.06.1017
DE90790628	AFME–83.1175
DE90790629	PIRSEM–3008
DE90790630	PIRSEM–2027.1
DE90790631	PIRSEM–3246
DE90790632	AFME-FR–11
DE90790634	FRCEA-R–51
DE90791076	INS–794
DE90791077	JAERI-M–89-182
DE90791081	KEK–89-11
DE90791083	JAERI-M–89-222
DE90791084	JAERI-M–89-206
DE90791085	RERF-TR–4-89
DE90791086	RERF-TR–3-89
DE90791087	RERF-TR–7-89
DE90791088	RERF-TR–11-89
DE90791105	INS–802
DE90791106	JAERI-M–89-213
DE90791115	PNC-TN–8410-89-047
DE90791119	JAERI-M–89-221
DE90791126	INS–798
DE90791127	INS–800
DE90791128	INS–801
DE90791129	INS–799
DE90791130	JAERI-M–89-223
DE90791131	JAERI-M–89-224
DE90791132	JAERI-M–89-225
DE90791138	JAERI-M–89-227
DE90791139	RRK–90-1
DE90791140	PNCT-N–9410-89-112
DE90791141	PNCT-N–9410-89-159
DE90791142	INS–805
DE90791143	KURRI-TR–325
DE90791144	JAERI-M–89-220
DE90791145	JAERI-M–90-002
DE90791146	JAERI-M–90-004
DE90791148	JAERI-M–90-008
DE90791149	JAERI-M–90-009
DE90791151	JAERI-M–90-013
DE90791168	JAERI-M–90-031
DE90791170	JAERI-M–90-003
DE90791245	KURRI-TR–321
DE90791246	KEK–89-9
DE90791261	HIFT–165
DE90791262	HIFT–167
DE90791294	DTH-LV-MEDD–190
DE90791308	RRK–89-28
DE90791310	INS–786
DE90791312	JAERI-M–89-133
DE90791318	SL–1271-87828
DE90791319	UTNL-R–239
DE90791320	DMI–89836-Vol.1
DE90791322	DMI–89836-Vol.2
DE90791324	SJF-Orientering–65
DE90791327	NIRS-RSD–84
DE90791336	NIRS-R–18
DE90791338	NIRS-R–17
DE90791370	CMI-R–89/30701
DE90791371	NVE-V-PUB–21
DE90791373	NVE-U-R–04-88
DE90791375	IKU-R–31.8842.00/01/89
DE90791377	IKU-R–34.2783.03/01/89
DE90791379	IKU-R–34.2802.02/01/89
DE90791950	FAL-IfBW–4/88
DE90792211	Juel–2342
DE90792214	Juel–2339
DE90792215	KFK–4671
DE90792217	KFK–4691
DE90792220	BONN-IR–90-05
DE90792222	KFK–4692
DE90792226	IPP–III/152
DE90792228	IPP–III/153
DE90792230	IPP–III/156
DE90792232	IPP–III/155
DE90792234	IPP–6/287
DE90792235	BONN-IR–89-46
DE90792247	IKE–4-132
DE90792249	IKE–6-179
DE90792258	BONN-IR–89-43
DE90792264	MPI-PAE/Exp.El.–214/89
DE90792271	GSI–90-06
DE90792292	GSI–90-05
DE90792294	Juel-Spez–535
DE90792295	GSI–90-03a
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DE90792468	KFK–4694
DE90792487	GSF–9/89
DE90792515	KFK–4649
DE90792517	GSI–90-07
DE90792519	GSI–90-07a
DE90792534	KFK–4706
DE90792554	KFK-PEF–60
DE90792572	GSF–10/89
DE90792879	FRNC-R–274
DE90792881	PCCF-T–88-12
DE90792882	CEA-DAS–540
DE90792883	IPNO-TH–88-55
DE90792884	PCCF-T–88-13
DE90792885	FRCEA-R–44
DE90792901	CEA-CONF–9981
DE90792917	CEA-R–5506
DE90792918	FRCEA-TH–238
DE90792919	CEA-R–5486
DE90792920	CEA-TH–260
DE90792921	CEA-N–2616
DE90792922	ISN–89-46
DE90792923	ISN–89-47
DE90792924	ISN–89-37
DE90792927	IPNO-DRE–89-40
DE90792947	CEA-R–5496
DE90792948	CEA-R–5494
DE90792949	CEA-CONF–9871
DE90792952	CEA-CONF–9812
DE90792957	CEA-CONF–9798
DE90792985	LPN–89-01
DE90792986	IPNO-TH–88-89
DE90792987	IPNO-TH–88-88
DE90792988	IPNO-TH–88-45
DE90792989	LPNHEP–88-05
DE90792990	CRN-HE–88-07
DE90792991	CRN-HE–88-04
DE90792994	CEA-CONF–9854
DE90792998	LAPP-TH–240-89
DE90792999	LAPP-TH–248-89
DE90793000	LYCEN–89-11
DE90793001	CEA-CONF–9903
DE90793002	GANIL-T–89-01
DE90793016	CEA-R–5508
DE90793017	CEA-R–5489
DE90793018	IPNO-DRE–89-36
TI90010259	DOE/IG–0284
TI90010260	DOE/IG–0282
TI90010274	DOE/IG–0283
TI90010754	NUREG/IA–0023-Vol.1
TI90010755	NUREG/IA–0023-Vol.2
TI90010806	NUREG/CR–5409
TI90010814	NRRI–90-5
TI90010827	NUREG–1399
TI90010836	HNEI–90010836
TI90010879	USGS-OFR–90-31
TI90010900	USGS/MAP/I–2047
TI90011026	NUREG/CR–5557
TI90011027	NUREG/CR–5397
TI90011028	NUREG/CR–4639-Vol.1-Rev.1
TI90011057	NUREG/CR–4550-Vol.3-Rev.1-Pt.1
TI90011058	NUREG/CR–4550-Vol.3-Rev.1-Pt.2
TI90011132	NUREG–0750-Vol.30-Index-2
TI90011138	NUREG–1390
TI90011244	NUREG/CR–5262
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